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Factors Affecting the Composition of Common Glassware*

By J. B. Krak

GLASS making in its simplest form consists in fusing together a mixture of sand, soda ash and limestone, and glass of excellent properties can be made in this manner. A notable example is plate glass which has many desirable qualities such as hardness, brilliancy, strength and ability to withstand weathering. Its composition may be considered as representative of common glass.

Different plate glass factories use batches of slightly varying compositions, but the following are typical of present day practice:

I				II			
Batch		*Glass*		*Batch*		Glass	
Sand	1,000	SiO_2	72.2%	Sand	1,000	SiO_2	72.0%
Soda ash..	290	Na_2O	14.1	Soda ash .	310	Na_2O	15.1
Salt cake.	60	CaO	13.7	Salt cake.	65	CaO	12.9
Limestone.	340			Limestone.	320		
Arsenic ..	5			Charcoal .	3		
Charcoal .	3						

Composition of Glass Containers

Glass of the above composition cannot successfully be used in automatic machinery for the production of glass containers. Such glass will not remain plastic during the time required in the forming operation, beginning with the entrance of the molten glass into the mold or mold system and ending with the expulsion of the finished container. Since the rate of setting is largely governed by the amount of lime present in the glass, the obvious thing to do is to lower the lime content and to raise the percentages of silica and alkali. These changes, however, can only be made within fairly narrow limits. If the alkali is raised to over 17%, the glass will become unstable, subject to weathering and to the solvent action of the liquid within the container. If the silica is raised above 75%, devitrification is likely to occur.

With a three component system the present solution of this problem has all the disadvantages of a compromise. It has never been accepted as final and efforts are constantly being made to find a more satisfactory glass for machine operation. Considerable progress has been made in this direction but we are as yet a good distance from the ultimate solution.

Practical experience has shown that glass becomes stronger, easier to melt, has better working qualities, and is in general more suitable for machine production with increase in the number of elements it contains. This has been proven by scientific investigation.

The older generation of glass makers found it difficult to believe that alumina and magnesia are beneficial to glass. Nevertheless the use of feldspar and of dolomitic limestone has become general. The value of alumina to the glass container industry lies in the fact that it may act either as a base or as an acid and can replace in limited amounts silica, sodium oxide and lime. It acts as a stabilizer similar to lime, it allows a decrease of alkali which diminishes the tendency to weathering, and, when replacing silica it slightly improves the fusibility. Glass analyzing from 1½ to 2¼ percent alumina is distinctly superior to glass that is practically free from alumina but otherwise of similar composition.

Advantages of Alumina

The advantages of alumina in glass can be summarized as follows—

Alumina (up to about 2½ percent):

1. Lowers the coefficient of expansion thereby making glass more resistant to thermal shock.
2. It increases the mechanical strength, crushing strength and tensile strength, thereby making glass more resistant to rought handling.
3. It increases resistance to weathering and attack by liquids.
4. Increases brilliancy and luster.
5. Increases the working range of molten glass, thereby making it more suitable for machine production.
6. When alumina replaces lime or silica it increases fusibility, thereby making possible greater output of finished glass and a saving of fuel.
7. Glasses containing alumina are less corrosive in their action on the tank blocks or pots.

* Contribution from the laboratories of The Roessler & Hasslacher Chemical Company, Perth Amboy, New Jersey.

8. Alumina decreases scum and devitrification, thereby making the glass more suitable for machine production.

9. When alumina replaces silica it produces a more solid, more elastic and more ductile glass.

The best way to introduce alumina into glass is by the use of feldspar, because feldspar is inexpensive, easily fusible and obtainable in a very pure state. It contains from 16 to 18 percent alumina, 12 percent potash or soda, or mixtures of these two, depending on the type of feldspar, a very small amount of lime and magnesia and the best grades contain less than 0.1 percent iron oxide. The loss on ignition usually does not exceed 0.5 percent.

Commercial feldspar consists of a mixture of potash spar, soda spar and lime spar, containing also quartz and mica. The material as mined varies considerably in composition. Care in selection while mining, and further sorting before grinding largely determines the purity of commercial feldspar. Iron bearing minerals are particularly undesirable. Systematic chemical control over the finished product aids in insuring constancy of composition.

The color of spar should be a pure white. Some spars are colored by a small amount of manganese. This, of course, is not objectionable, as manganese is often added to glass to improve the color. However, any colored spar is of doubtful quality until analysis has demonstrated that the color is not due to iron oxide.

Addition of Feldspar

The amounts of feldspar that can be added profitably to a glass batch varies with a number of conditions. First of all, it depends on the amount of alumina derived from the sand, limestone or cullet. The best way to determine this quantity in one operation is to make an analysis of the glass.

Glass should not contain more than 2 to 2.5 percent of alumina as a larger amount would make the glass too viscous for machine operation. If the raw materials and cullet already supply 1 percent, it is only necessary to provide the additional amount of alumina by means of feldspar.

The glassmaker should carefully consider the end he wishes to attain. If maximum pull on the tank is the object, the alumina should be kept low. It should preferably replace silica and lime, otherwise the slight increase in viscosity caused by alumina may be enough to cause insufficient fining in the alloted time and give seedy glass. On the other hand, if quality is paramount and quantity of output is of secondary importance, the alumina should be maintained around 2.5 percent.

Addition of Borax

Another material has recently become available to makers of common glassware. Due primarily to the fact that borax is now being produced in large quantities from the waters of Sarles Lake and also owing to the discovery of large deposits of borax mineral, the price of borax has dropped to about $50.00 a ton. A small percentage of boric oxide has a considerable effect on the properties of glass. As little as 1 percent has been found to increase the fusibility of glass and to lower the temperature at which glass can be melted and fined. The advantages of boric oxide in glass can be summarized as follows:—

1. Borax, even in small amounts such as 50 pounds of borax to 1000 pounds of sand, makes possible a heavier pull on the tank without danger of seeds. In other words, if there is a heavy pull on a tank causing seeds, these will ordinarily disappear with the addition of borax. At the same time, there is no increase in fuel consumption, and the saving thus effected more than offsets the cost of the borax.

2. Boric oxide decreases the thermal expansion which will allow steaming or cleaning of bottles in hot water with less breakage.

3. It gives the glass greater resistance to mechanical shock.

4. Increases resistance to the solvent action of contained liquids.

5. The ware has greater resistance to pressure breakage.

These advantages should appeal to manufacturers of milk bottles, feeding bottles for infants, prescription bottles, jam jars, preserve jars, the contents of which are hot when poured, and of jars for meat packers who heat or evacuate containers after filling them.

Formula for Container Glass

Based upon the above considerations a batch formula has been developed which has given excellent results in a number of container factories. The outstanding advantages of glass of this nature are its great resistance against the action of solvents and against weathering, the ease with which the glass is melted and fined, the good working qualities in automatic machinery and the large output of high grade brilliant glass which is obtainable.

Batch Formula

Sand	1000
Soda Ash	360
Salt Cake	5
Lime (Burnt)	110
Feldspar	100
Borax	50

Calculation of Glass Composition

Silica (SiO_2)		1070
from Sand	1000	
from Feldspar: 100 x .70 =	70	
	1070	
Sodium Oxide (Na_2O)		224
from Soda Ash: 360 x .585 =	210.60	
from Salt Cake: 5 x .437 =	2.19	
from Feldspar: 100 x .03 =	8.15	
from Borax: 50 x .163 =	8.15	
	223.94	
Potassium Oxide (K_2O)		9
from Feldspar: 100 x .09 =	9	
Alumina (Al_2O_3)		18
from Feldspar: 100 x .18 =	18	
Lime (CaO)		110
from Burnt Lime: 110 x 1 =	110	
Boric Oxide (B_2O_3)		18
from Borax: 50 x .366 =	18.3	
Total		1449

Glass Composition

Silica (SiO_2)	73.85%
Sodium Oxide (Na_2O)	15.46
Potassium Oxide (K_2O)	0.62
Alumina (Al_2O_3)	1.24
Lime (CaO)	7.59
Boric Oxide (B_2O_3)	1.24
	100.00

Acids:		Silica and Boric Oxide	75.09%
Bases	Fluxes:	Sodium Oxide and Potassium Oxide	16.08
	Stabilizers:	Lime and Alumina	8.83
			100.00

Average Composition of Potash Feldspar

(As used in calculations)

Silica (SiO_2)	70
Alumina (Al_2O_3)	18
Sodium Oxide (Na_2O)	3
Potassium Oxide (K_2O)	9
	100

Borax contains 16.3 percent of sodium oxide and 36.6 percent boric oxide, the remaining 47.1 percent being water of crystallization. Therefore, if borax is added an equivalent amount of soda ash or salt cake should be substracted. The following factors apply:—

$Na_2B_4O_7 \cdot 10\ H_2O \times .163 = Na_2O.$
$Na_2B_4O_7 \cdot 10\ H_2O \times .366 = B_2O_3.$
$Na_2CO_3 \times .585 = Na_2O.$
$Na_2SO_4 \times .437 = Na_2O.$

Therefore one part of borax is equivalent to $\frac{163}{585} = 0.278$ parts soda ash and to $\frac{163}{437} = 0.373$ parts salt cake, with regard to Na_2O.

For every 10 pounds of borax added to a batch, 2.8 pounds of soda ash or 3.7 pounds of salt cake should be deducted. Addition of 50 pounds of borax results therefore in a saving of 14 pounds of soda ash or 18½ pounds of salt cake.

It has been proved in practice that 5 pounds of salt cake to 1000 pounds of sand is usually effective as a remover of scum. A larger amount does no particular harm to the glass but it is hard on the refractories which is reason enough to avoid a quantity in excess of the amount required.

Obviously there is no one batch formula that can be considered the best for every factory. Furnace conditions, the size of the tank, the rate of pull, the temperature, all vary and it must be left to the judgment of the glassmaker to select a composition that will fit the particular conditions prevailing in his plant. The above formula is not to be considered as standard. It should be accepted only as one from which others can be derived, suited to the conditions that have to be met.

When changes are made in a tank glass batch formula, it is always advisable to make them very slowly to avoid cords.

In judging the balance of a glass composition, the boric oxide should be added to the silica. The alumina should be added to the lime as a stabilizer and setting agent. The above calculation shows that in the feldspar-borax combination we have the means of producing a glass of better physical qualities and chemical composition than is possible with any combination of the three component systems. Experiments have proven it to be a glass more suitable to automatic machinery than any formula heretofore proposed.

Glass Technologists Discuss Tank Block Erosion

The 115th meeting of the Society of Glass Technology was held in the University, Leeds, England, on Wednesday, March 20th, 1929, the President, Mr. Walter Butterworth, Senr., M.A., in the chair.

The following is one of two papers presented, the other being on the selection of coal for gas producers, by E. J. C. Bowmaker, B.S.C., and J. D. Cauwood, M.Sc.

Investigations into the Erosion of Tank Blocks

By F. F. S. Bryson, M.B.E., M.A., B.Sc., F. Inst. P.

The subject matter of this paper had formed one report issued in the thirteenth Bulletin of the Glass Research Association in 1925.

A method was described of determining the rate of erosion of tank blocks while in position in a furnace actually in operation. The investigations were carried out at a works in the London area, the tank being oil-fired and worked for the melting of white bottle glass.

Sixteen thermocouples were inserted into the interior of blocks forming the side wall of the tank, and one into the bridge. The couples were placed as near as possible to a depth of 7 inches in each block which was 8 inches thick, thus leaving 1 inch of block between the couple and the glass. Continuous records of the temperatures of the various couples were made throughout the life of the furnace.

Shortly after the furnace was lit, air-cooling was installed. The rate of increase of the temperature of any couple indicated the rate of erosion of the block at that particular point.

The temperature records, plotted against the time from the beginning of the investigations were shown on lantern slides, and the regions of equal erosion in the blocks were also shown graphically. The results were summarized as follows:

(1) The air-cooling resulted in a lowering of temperature of the outer, and, to some extent, of the inner walls, but it was not evident that a layer of chilled glass was formed on the inner surface of a block of only 4 inches thickness.

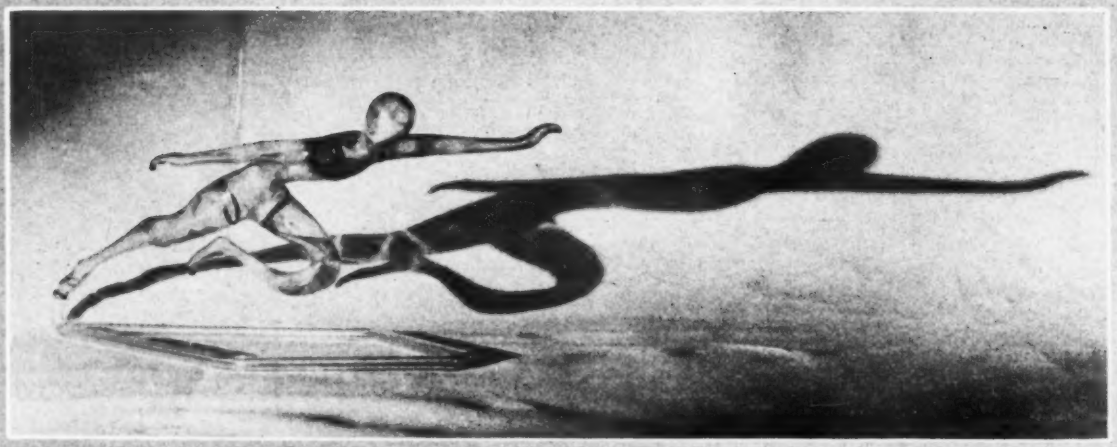
(2) The temperature of the glass in contact with the top blocks permitted of currents being formed in the glass, thus aiding solution. The movements of the glass near the bridge were different from those near the doghouse, as was evidenced by the difference in the nature of the erosion in the two regions.

(3) The glass temperature varied, due to the variations in the amount of glass being worked out.

(4) The rate of erosion near the glass level was very rapid at first, then the rate fell; at a depth of 10 inches below the glass surface, the rate was not so rapid, while at a depth of 16 inches it was slow.

(5) At the glass level the attack was most severe seven feet from the bridge.

(6) The surface temperature of the glass was greatest about midway between the doghouse and the bridge, while at the bottom of the tank the temperature was highest near the bridge end.

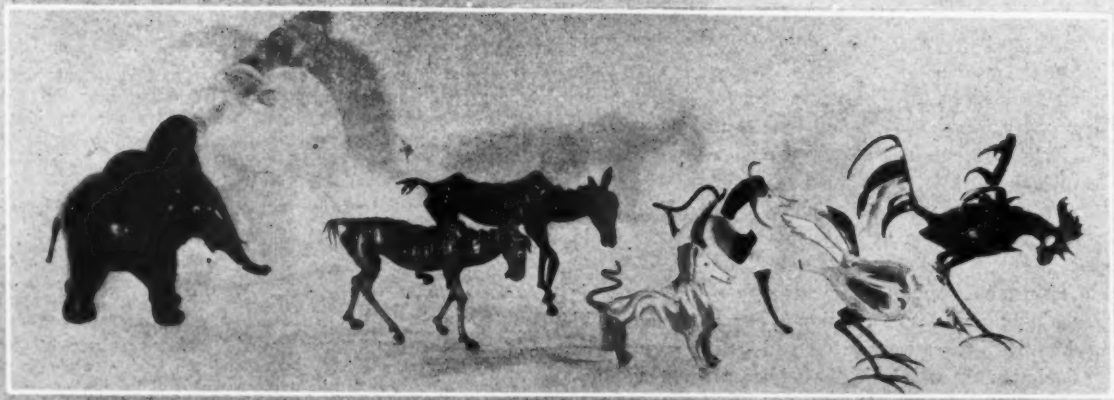


MARIANNE VON ALLESCH of Berlin made her bow before the American public in the role of a decorator as a collaborator with Eugene Schoen the Architect in the child's nursery now on exhibition at the Metropolitan Museum of Art in its show of Contemporary American design.

During the month of March, Eugene Schoen Galleries staged an exhibition for Mrs. Marianne von Allesch in her chosen field; that of blown glass.

Mrs. von Allesch believes herself to be the originator of modern glass figures and glass flowers. She first presented her creations at the Decorative Arts Exhibition in Paris in 1925 and subsequently exhibited her work in London and many other important cities on the continent.

Mrs. von Allesch is a glass-blower herself and master craftsman and artist. The Government of Thuringia commissioned Mrs. von Allesch to come to America in order to develop new designs for the American Christmas tree ornament market, for in Thuringia are all the flimsy glass ornaments for the Christmas tree made for practically the whole world. Her whimsical figures have had a great success in America and can be seen in many department stores and gift shops.



New Light Through Glass

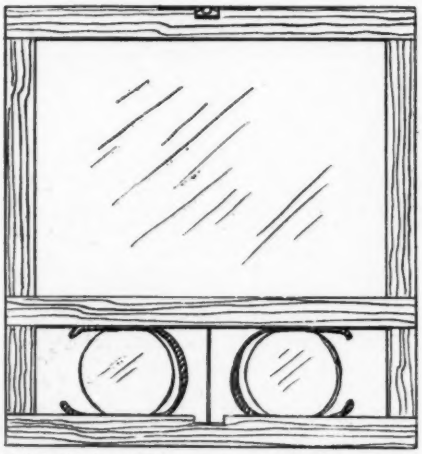
By Wynna Wright

THERE has been arousing considerable curiosity and interest in New York of late a simple but remarkable device known as the "Cross" Glass. It consists of a wooden frame 9⅜ x 9½ inches in which are set a spirit level, a sheet of plain window glass 6 x 8 inches, backed by a white card and a pair of equal plano-convex lenses about 1½ inches in diameter and of about 15-inch focal length. Inserted between the two lower cross pieces of the frame by means of protective metal bands sliding in grooves, these lenses may be moved at will to right or to left.

The purpose of the "Cross" Glass is to aid one in acquiring true vision of action, proportion, perspective, value, and color. It may, then, be termed a drawing and painting glass. The idea is not wholly new. Leonardo da Vinci had a device for tracing upon glass and then from the glass to paper. Madame Cavé, in 1850, made use of transparent gauze on which the subject was traced for the purpose of self-correction in memory and nature drawings. Eugene Delacroix spoke of it as the only method of drawing that really taught anything. But the method of the "Cross" Glass is an improvement on Madame Cavé's method. From the outset it trains one to be self-reliant. Persons misinformed or superficial in their thinking, have jumped to the conclusion that this is just another tracing device, upon which, as upon a prop, one would be continually tempted to lean, whereas its function is diametrically opposed to any such process.

Using the clear glass, with the white card behind it, in place of paper, and the "Cross Crayon" in place of pencil, one draws on the glass simple objects that can be sketched in a few seconds or minutes. This is done without any measuring or testing whatsoever, but as accurately as possible with the eye alone. When one believes the drawing to be correct one applies the test of removing the card, leveling the glass, and holding it at just the distance where the drawing upon it appears to cover the object: where the outlines coincide with those of the object it is correct, where they do not it is incorrect. This, therefore, is a method of self-correction that presents instantaneous proof of one's mistakes. One can see just where one's eye—and hence one's drawing—is "off," and just how the lines should go in order to make the drawing true. There is no need of taking another's "say so"—while secretly thinking that he may not be much nearer right than oneself, and that perhaps one's drawing is pretty accurate after all! Here is the evidence, to be seen with one's own eyes, and hence not to be disputed. One knows just where one stands and therefore can proceed with definiteness to correct one's fault. With more and more practice in this direct way one finds one's drawings tallying more and more closely with the objects until so reliable has the eye become that one may discard the mechanical test and go ahead with assured confidence in one's own strength.

The principle applies in like manner to training the eye to see true color and value; in this process it is the lenses, instead of the plain glass, that are used. If, for example, one is making a study of a group of still life, one indicates on paper or canvas the general mass, color, and value seen in the group. When these are as accurate as one can make them with the eye alone, one places the painting beside the group itself and at a distance where it will appear of the same size. Then, holding the glass so that, with one eye closed, the group is seen in one lens and the painting in the other, one proceeds to look *at* the lenses instead of through them, and to think only of what appears on these surfaces. Since the lenses blur, they obliterate all but mass, color, and value, thus freeing one from form and detail and the associations that go with them and distract the eye from true perception of color quality. By focussing the eye midway between the lenses it sees in one glance both images,—that of the original group and that of the painting. It can thus make an instantaneous comparison of the two which, if the painting be accurate, will blur alike. It will be found that the untrained eye underestimates the amount of color and contrast of light and dark present in objects, so that the image of the painting will almost invariably be weaker in color and value than that of the group. But, with continued study of the objects as they are translated by the lenses and practice in reproducing them with a vision that is being constantly strengthened by repeated tests, the eye becomes sensitized to color where it saw only gray or "dark" before. Even artists who have "painted for years," and



"CROSS" DRAWING AND PAINTING GLASS
As Used in the Home Study Course of Columbia University.

have at first taken up the Glass in a spirit of derision as "another of those mechanical aids," or in amused curiosity to see "what it was all about," through experimenting with the lenses have had their eyes opened to more color than they had ever before been aware of. And by the tests that the Glass provides, John Singer Sargent himself apparently profited, for he wrote, "Frequent use of the Glass will put one on guard against any habitual error."

Anson K. Cross, the inventor of this drawing and painting Glass, in his first book "Free-hand Drawing," published

in 1895, explained that he made use of clear window glass simply as a drawing tablet in place of paper, that the drawing was made on it entirely free-hand, a sheet of white cardboard serving as background, and that no test was applied until the drawing had been made as perfect as possible by the eye alone; then the card was removed and the glass looked through to see if the drawing would appear to cover the object. At that time there was no spirit-level used with the glass, an accessory which experience proved quite essential if the student were to see angles truly. With this addition the "Cross" Drawing Glass was patented in 1912 and was awarded a bronze medal at the Panama-Pacific Exposition in 1915. With the fairly recent incorporation of the lenses the device became doubly useful and in 1921 was patented as the "Cross" Drawing and Painting Glass.

Mr. Cross has been a teacher of drawing since 1881. He was a member of the faculty of the Massachusetts Normal Art School (now the Massachusetts School of Art) from 1883 to 1921, and an instructor in the School of the Museum of Fine Arts in Boston from 1891 to 1927. In both schools his students made remarkable progress through the use of the Glass. In the latter years of his teaching at the Museum School he was also conducting a Home Study Class with very noteworthy results. Artists were amazed to see, in this as well as in the school courses, the power gained in a few months by students whose first sketches showed little, if any, ability. Joseph De Camp said, "I have never seen in my long years of teaching such remarkable results as those you have obtained by use of the Drawing Glass"; Cyrus Dallin: "The results you have achieved are a most striking testimonial to the value of the Drawing Glass"; Denman Ross: "I have used your Drawing Glass in my classes and have urged other teachers to use it. It should be used in the schools wherever free-hand drawing is taught"; Edmund Tarbell: "The Glass is the best aid to drawing ever made. I wish it could be adopted by every school in the land"; H. Dudley Murphy: "Your method is the most practical, for it trains the eye of the student to see correctly not only form, proportion, and perspective, but values and color. Visual training is the first necessity to the painter, and you make him his own critic with an instrument that is absolutely without prejudice or fault"; and Charles Grafly: "Your teaching, in a way almost beyond belief, enables the beginner to gain a sure eye and touch. Your method in the study of drawing and painting is the most practical I have ever known. When those in charge of public, elementary, and art schools see the wisdom of such a course,—as they must when it is realized that the proper use of the Drawing and Painting Glass is not mechanical but merely a means to an end,—then the student will be better equipped to see, and to see, after all, is one of the greatest things we are able to teach."

Some two to three years ago Columbia University, wishing to add a course in drawing and painting to its list of home studies, learned of Mr. Cross' notable success with his own home study course, and as a result, was able to take it over with Mr. Cross as its director. In these two years it has so grown in its enrollment—now numbering 600 students in various parts of the world—that Mr. Cross has, with the exception of his Summer School in Boothbay Harbor, Maine, given up all other instruction.

The Columbia University Correspondence Course teaches anyone to see Nature truly and proves that when one can see truly he can draw and paint the truth he sees. Mr. Cross writes to his students: "You must not think there is any magic in my method or book or instruction that offers a short cut to art. It is not a short cut to art but to the true vision which has been considered, by all except the modernists, to be the alphabet of art." This, Mr. Cross is convinced, all who have the desire and the willingness to work may attain. He goes on to say:

"It will not necessarily mean more artists, for they are born instead of developed by education. It will, however, develop the perceptive faculties of the public so that all may see the beauties of nature and art with the vision of the great painters. This accomplished, the public will buy for love of beauty and not for the reputations of artists of the past or the present, whose works may be increasing in dollar values. Thus life will be more beautiful and spiritual for all, while all the arts and industries will prosper from the increased perceptive and reasoning powers due to better visual education."

A recent exhibition held at Columbia of work by students of Mr. Cross, showing that done after use of the Glass in comparison with that done before its use, gives ample proof that whether or not the artist quality be present, many individuals are gaining a mastery of the terms most essential for the artist's clearest and most fluent expression, and along with that, an awakening to beauty of which their work shows them to have been totally unaware up to that time. The letters from these students give further indication of this enrichment of their consciousness. They are full of such enthusiasm and gratitude that if one saw them in print one might be inclined to think them exaggerated for advertising purposes; whereas they are in reality revelations not merely of a new perception of outward appearances, but a realization of increased joy in living.

The Exhibition is being sent "on tour" to other cities for the purpose of arousing wider public interest in the benefits that this vision-training method affords, and in the hope of finding friends who will wish to contribute to an Endowment Fund for making it more efficient and far-reaching in its influence.

With growing recognition of the value of the "Cross" Drawing and Painting Glass, the demand for this clever device should be considerably extended.

Uranium and Cobalt Salts in Belgium

Belgium is now the world's principal producer of radium, which is extracted from ores brought from the Belgian Congo to a plant at Colen near Antwerp. The by-products of this new industry include uranium and cobalt salts, which supply mineral colors of value to glassworks and ceramic factories. The ores are obtained on advantageous terms, the American production of radium has been adversely affected, and American supplies are largely obtained from Belgium. Belgian exports of radium in 1926 were valued at $423,732; in 1928 $584,336.—*Consul E. E. Silvers, Antwerp.*

The Physical Properties of the Glasses and Their Relation to the Composition*

The Mechanical Properties of the Glasses

By G. Gehlhoff and M. Thomas

(Continued from the April, 1929, issue)

Transverse Strength

NO systematic investigations are available on the transverse strength of glasses. Only incidental observations were made such as those by Kowalski[11] and Brodmann[12]. Brodmann's measurements, as well as those of Kowalski, related only to a single glass. Brodmann, who primarily checked the measurements of Kowalski, found that a glass with a fire-gloss had a considerably lower transverse strength than one in which the surface layer had been removed by etching. These measurements by Brodmann also refer to very thin glass rods (about 1.8 mm. diameter) in which therefore, the fire-gloss might be of considerable importance. This reduction of the transverse strength by the fire-gloss is similar to the observation made by Bach,[13] that cast iron has a very different transverse strength with and without the casting skin: and as a matter of fact here also, the transverse strength is increased by the removal of the skin. The same author determined further that the values for the transverse strength in cast iron are not exactly the same, depending on whether the test bars are rectangular or round in cross section. Even with the same cross sectional shape the transverse strength still depends on the size of the cross section in that thicker rods have a lower strength than thin ones. These unconformities depend essentially on the fact that in the derivation of the transverse strength formula under consideration, assumptions were made which hold for small bends, while their validity may be questioned with large bends. In recent investigations on the transverse strength of glasses so far as we could judge, there is available only one rather large experimental series by Graf[14] on the strength and especially the transverse strength of plate glasses and also wire glasses, which appeared during this work. From the results of Graf we see that there is an extensive proportionality between bend and load up to fracture within the limits of sensitivity in his investigations, a confirmation of the definition of a brittle substance in which the slightest exceeding of the elastic limit leads to fracture. In addition, Graf showed that scratches on the surface of the glass reduce the transverse strength considerably if they are on the tensile side and that scratches on the compression side have little or no influence. This observation was confirmed by Ewald.[15] We must not take too much for granted in the experiments of Graf as regards the influence of the individual glass-formers on the transverse strength as the glasses had only slightly different composition, namely, the composition of ordinary soda lime glasses such as are used in the manufacture of plate glass.

Our experimental arrangement was extremely simple: the rod to be tested was placed on two stationary knife edges 10 cm. apart and loaded by means of a vessel hanging from a thread, to which mercury was added. The suspension was exactly at the center using a stop arrangement. As the rods accidentally were not perfectly round, the relation for elliptical rods was chosen:

$$F_b = \frac{P \cdot l}{a^2\ b\ \pi};$$

in which F_b is the transverse strength, P the weight of the load, l the distance between the knife edges, *a* the small axis of the rod and *b* the large axis of the rod, which was always placed on the less curved side of the ellipse. Since as has been mentioned above, the transverse strength depends to a slight extent on the cross section, that is the formula given above does not agree perfectly, the relation of the transverse strength to the size of the cross section was studied accurately on a certain glass after (a lead glass used for manufacture of incandescent lamps). As Fig. 14 shows, we found the

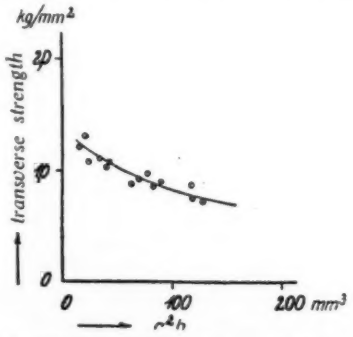


FIG. 14. TRANSVERSE STRENGTH IN RELATION TO THE DIMENSIONS OF THE CROSS SECTION.

fact already stated by Bach, that the transverse strength decreased a little with increasing cross section. In order to obtain comparable data for different glasses, one should study only rods of the same diameter; one would therefore have to establish a given diameter as Bach has also proposed for metals. As in our case due to the limitations of the material available it was not possible to obtain a given rod diameter from each glass, the rods on hand were used for the measurement and the results thus obtained were reduced to a standard dimension according to Fig. 14. For this a value $a^2b = 40$ sq. mm. was selected and this only because

* Communication from the Technical Glass Laboratory of the Osram Company, Weisswasser, Germany. Zeitschrift für technische Physik, v. 7, p. 105-260.

[11] Kowalski, Festigkeit des Glases. Wied. Ann. 36 (1889) 307.

[12] Brodmann, Nachrichten von der Kgl. Gesellschaft d. Wissensch. zu Göttingen 1894, 44.

[13] Bach, Elastizität und Festigkeit, Berlin 1911. p. 256.

[14] Graf, Versuche über die, Elastizität and Festikeit von Glas als Baustoff. Glastechn. Berichte 3 (1925) 155.

[15] Ewalk, Beitrag zur Bestimmung der Bruchfestigkeit von Glas und Kristallen. Die Glasindustrie 34 (1925) 3.

most of the rods had a diameter such that an interpolation was possible to the value $a^2b = 40$ sq. mm.

The values obtained according to this method could be reproduced with an accuracy of $\pm$ 7% with the exception of some glasses for which there was no good rod material available.

The effect of the surface could not be determined in the rods used with diameters from 3 to 5 mm. Rods with fire-gloss and those in which it had been removed extensively by etching (average reduction of diameter 0.3 mm.) showed exactly equal values. Thus for a given lead glass the following values were obtained:

	Transverse strength
Strained rod	1.26 kg/sq. mm.
Annealed rod	1.23
Etched rod	1.29

This result, which differs from that of Brodmann, is explained again by the fact that with the comparatively large cross sections of our rods the effect of the fire-gloss disappears. As can be seen from the data, there is no difference in the transverse strength of strained and annealed glasses.

Fig. 15 to 19 show the results obtained with the individual experimental series.

1. Monovalent Glass-Formers

Alkalies as compared with silicic acid increase the transverse strength considerably, and as a matter of fact soda is a little stronger than potash (Fig. 15). It is noteworthy

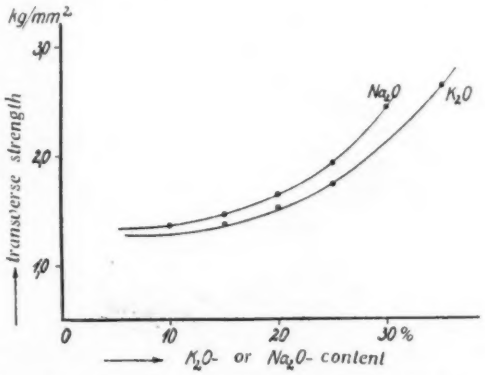


FIG. 15. TRANSVERSE STRENGTH ON REPLACING SiO_2 BY K_2O OR Na_2O.

that the influence of the alkalies with low percentage content is very slight and with greater additions it increases more strongly. On replacing Na_2O by K_2O the transverse strength changes only a little, and particularly, there is no pronounced ratio between Na_2O and K_2O at which the transverse strength reaches a maximum or minimum (Fig. 16).

2. Divalent Glass-Formers

CaO, BaO, and PbO, increase the transverse strength of the glasses strongly, and as a matter of fact CaO is the strongest and then come BaO and PbO (Fig. 17). Here it is even more noteworthy that the sequence of these oxides is the same as in their action on many other properties. Within increasing content of CaO, BaO, and PbO, the transverse strength is not increased as in the beginning, but with very high content of these oxides there is a decrease in

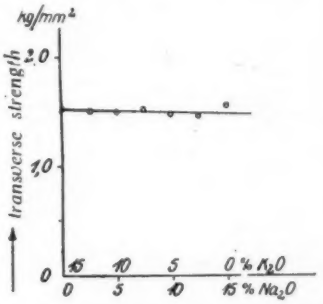


FIG. 16. TRANSVERSE STRENGTH ON REPLACING K_2O BY Na_2O.

the transverse strength. A similar action is obtained with ZnO (Fig. 18). With this oxide the transverse strength is increased a little at first and then it decreases again with

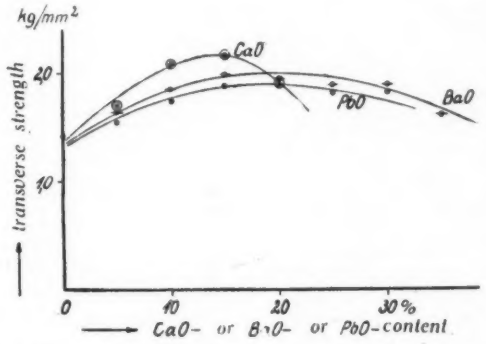


FIG. 17. TRANSVERSE STRENGTH ON REPLACING SiO_2 BY CaO, BaO OR PbO.

greater ZnO content. MgO has only a slight influence; the transverse strength is increased a little by the introduction of MgO.

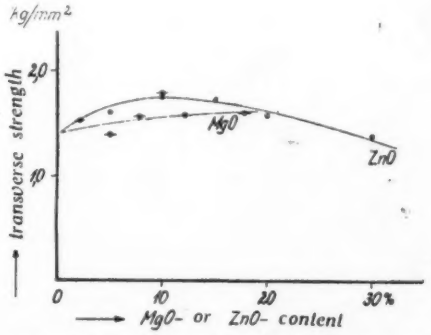


FIG. 18. TRANSVERSE STRENGTH ON REPLACING SiO_2 by B_2O_3, Al_2O_3 OR Fe_2O_3.

3. Trivalent Glass-Formers

By increasing introduction of B_2O_3 the transverse strength is first increased a little and then drops again with a higher content (Fig. 19). There is again a maximum at about 15% B_2O_3. Al_2O_3 decreases the transverse strength while it is increased to the same extent by Fe_2O_3.

If the glass-formers are arranged according to their in-

fluence on the transverse strength we get the following series with low percentage content:

CaO, BaO, PbO, ZnO, MgO, B_2O_3, Fe_2O_3, SiO_2, Al_2O_3

The alkalies cannot be arranged very well because they have

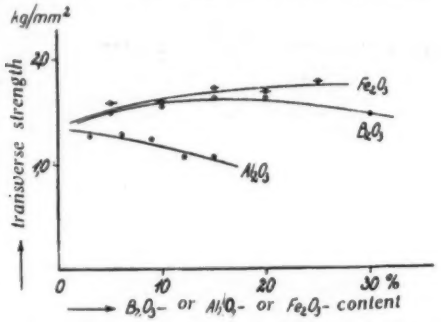


FIG. 19. TRANSVERSE STRENGTH ON REPLACING SIO_2 BY B_2O_3, AL_2O_3 OR FE_2O_3.

only a slight effect with low percentage contents and a very great effect with high percentage contents. From table 6 in which has been shown the amount by which the transverse strength changes on replacing 1% SiO_2 by 1% of another glass-former within a certain percentage range, we see the very different action of alkalies as compared with other glass-formers.

The calculation of the transverse strength of a certain glass which is shown in table 7, and which is made from a glass of similar composition, shows good agreement with the measured values. The measured value was 1.47 kg/sq.mm.

Compressive Strength

Winkelmann and Schott [16] made the first systematic measurements on the compressive strength of glasses as a function of the composition. As in all their other investigations, here also they used glasses with a large number of components, and with widely differing chemical composition, and then tried to draw a conclusion as to the influence of the individual glass-forming oxides on the compressive strength, and to calculate coefficients for the oxides with the assumption of a linear relation. They also found that the ratio of compressive and tensile strength in their glasses was not a constant as they had expected. They attributed the great differences in the values obtained for the ratio of compressive and tensile strength, to the very complex composition of the glasses. The differences between the observed values and the values calculated from the coefficients are comparatively large. Some measurements made by Graf on a crystal glass are available in more recent investigations[17].

Winkelmann and Schott used glass cubes about 6 mm. on a side for their investigations, while in order to simplify matters we used square plates of glass about 4 mm. on a side, and 1½ to 2 mm. thick. These plates were cut with a diamond from large rolled glass plates with a fire polish, and their surfaces were not worked further. For the investigation we selected about 20 plates of as square a cross-section as possible from the large number of plates that were cut; any projecting edges were ground down. The dimensions were measured with a micrometer. As compression apparatus we used a hydraulic press, the manometer on which readily showed pressure differences of 20 kg. The plates were laid between glass-hardened steel plates as shown in fig. 20; the lower plate with its hemispherical highly polished surface rested in a suitably shaped and hardened pan. This arrangement assured vertical pressure on the surface of the glass plate, as the hemisphere in the pan turned very easily. The two hardened plates on which impressions were made when compressing very strong glasses, were frequently re-hardened, ground and polished. This precaution proved to be absolutely necessary as a slight deterioration of the surface gave much lower compressive values than ordinarily. The glass plates were compressed until the glass exploded to dust with a loud report. The observer had to be protected by a screen. If there was a crack in the plate, which was indicated by a cracking noise, the recorded pressure at the subsequent explosion was always lower than normal. These values were therefore excluded. In spite of all these

[16] Loc. cit.

[17] O. Graf, loc. cit.

TABLE 6

	0—5%	5—10%	10—15%	15—20%	20—25%	25—30%	30—35%
Na_2O	—	—	+0,018	+0,36	+0,06	+0,10	—
K_2O	—	—	—	+0,028	+0,044	+0,076	+0,104
MgO	+0,024	+0,014	+0,006	0	—	—	—
CaO	+0,08	+0,06	+0,024	—0,05(?)	—0,026		—
ZnO	+0,04	+0,02	0	—0,016	—	—	—
BaO	+0,06	+0,046	+0,024	0	—0,004	—0,018	—0,038
PbO	+0,046	+0,036	+0,026	+0,006	—0,005	—0,16	—
B_2O_3	+0,025	+0,02	+0,014	0	—0,020		—
Al_2O_3	—0,014	—0,014	—0,014	--	—	—	—
Fe_2O_3	+0,011	+0,011	+0,011	—	—	—	—

TABLE 7

SiO_2	65%	83%	80,2%	74,7%	71,2%	70,7%
Na_2O	14	14	16,8	16,8	16,8	16,8
K_2O	1	1	1	1	1	1
CaO	—	—	—	5,5	5,5	5,5
MgO	—	—	—	—	3,5	3,5
BaO	20	2	2	2	2	2
Al_2O_3	—	—	—	—	—	0,5
Transverse strength .....measured	1,50	—5·0,024 —5·0,046 —3·0,06	+2,8·0,036	+5,5·0,08	+3,5·0,024	—0,5·0,14 =1,59

precautions, variations averaging 15% were found. In general the error was within 5%. The values given represent an average of about 20 measurements.

As the thickness of the glass plates being investigated varied from 1.5 to 2 mm., a special preliminary investigation was made to determine the relation of compressive strength to plate thickness of a glass. As curve *b* in fig. 21 shows,

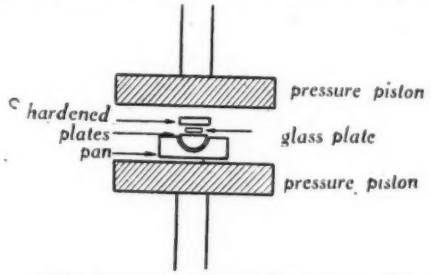


FIG. 20. ARRANGEMENT FOR DETERMINING THE COMPRESSIVE STRENGTH OF GLASSES.

the compressive strength of a stressed glass plate decreases slightly with increasing plate thickness. It may be proper to assume that this decrease in compressive strength with increasing thickness is caused by the greater stress in thick pieces of glass. Therefore the same investigation was made for annealed glass. Consequently curve *a* in fig. 21 for an annealed glass shows this relation of compressive strength to plate thickness. In the following investigations on experimental glasses we used the glass as it was received, that

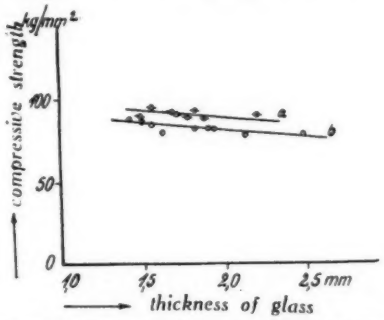


FIG. 21. COMPRESSIVE STRENGTH IN RELATION TO THICKNESS OF THE GLASS (a) ANNEALED. (b) STRESSED GLASS.

is, in a stressed condition. In order to be independent of the effect of plate thickness we selected glass plates from 1.5 to 2 mm. thick for the investigation.

The results obtained with the experimental glasses may be briefly outlined by means of the figures.

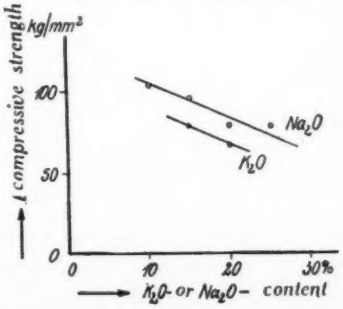


FIG. 22. COMPRESSIVE STRENGTH ON REPLACING SiO_2 BY K_2O OR Na_2O.

1. Monovalent glass formers. The alkalies have by far the greatest influence on compressive strength. Both reduce the compressive strength, potash more than soda (fig. 22). Mixed alkali glasses show compressive strengths that lie between those of glasses with only one alkali. A maximum or minimum, as is found with other properties for mixed alkali glasses, cannot be recognized here (fig. 23).

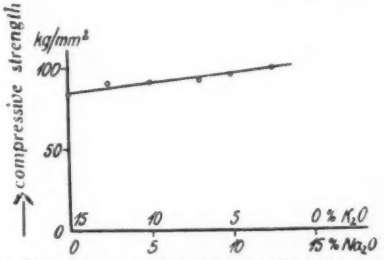


FIG. 23. COMPRESSIVE STRENGTH ON REPLACING K_2O BY Na_2O.

2. Divalent glass formers. Of the divalent glass formers, MgO and ZnO have only a slight influence on the compressive strength. CaO, BaO and PbO, on the other hand, reduce the compressive strength strongly and about to the same extent (fig. 24).

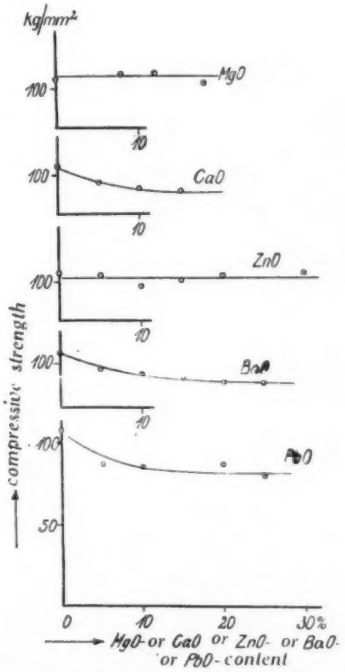


FIG. 24. COMPRESSIVE STRENGTH ON REPLACING SiO_2 BY MgO OR CaO OR ZnO OR BaO OR PbO.

3. Trivalent glass formers. The compressive strength is slightly reduced by B_2O_3. There does not seem to be maximum or minimum at about 15% B_2O_3. Al_2O_3 slightly increases the compressive strength, while Fe_2O_3 reduces the compressive strength considerably (fig. 25).

In table 8 we give the amount by which the compressive strength changes when 1% SiO_2 is replaced by 1% of another glass forming oxide within a certain percentage range. As these figures show, the oxides can be arranged in the following sequence as regards their influence on the com-

TABLE 8

Percentage Content	0—5%	5—10%	10—15%	15—20%	20—25%	25—30%
Na_2O	—	—	—1,6	—2,2	—2,6	—
K_2O	—	—	—	—2,4	—	—
MgO		very slight				
CaO	—2,0	—0,8	—0,2	—	—	—
ZnO		very slight				
BaO	—1,4	—0,8	—0,5	—0,3	—0,3	—
PbO	—2,0	—1,1	—0,4	—0,3	—0,2	—
B_2O_3	0	0	—0,5	—0,7	—0,8	—
Al_2O_3	+0,25	+0,25	+0,25	—	—	—
Fe_2O_3	—0,5	—0,6	—0,8	—1,4	—	—

TABLE 9

SiO_2	65%	83%	80,2%	74,7%	71,2%	70,7%
Na_2O	14	14	16,8	16,8	16,8	16,8
K_2O	1	1	1	1	1	1
CaO	—	—	—	5,5	5,5	5,5
MgO	—	—	—	—	3,5	3,5
BaO	20	2	2	2	2	2
Al_2O_3	—	—	—	—	—	0,5
Compressive strength.	measured 100	+5.0,3 +5.0,5 +5.0,8 +3.1,4	—2,8.2,2	—5,5.2,0	0	+0,5.0,25 = 95 kg/mm²

pressive strength: Al_2O_3, SiO_2, MgO, ZnO, B_2O_3, Fe_2O_3, BaO, CaO, PbO, Na_2O, K_2O. The underlined compounds have about the same effect.

A comparison of the results obtained for the compressive strength with those for tensile strength show immediately

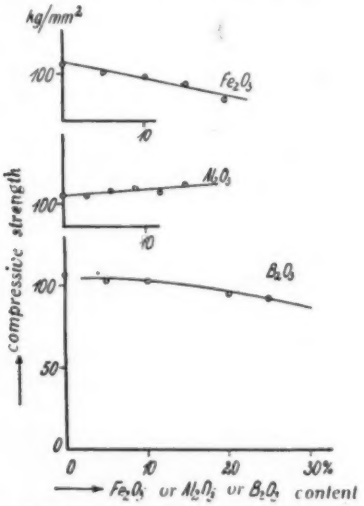


FIG. 25. COMPRESSIVE STRENGTH ON REPLACING SiO_2 BY Fe_2O_3 OR Al_2O_3 OR B_2O_3.

that there is no proportionality between compressive and tensile strength as was stated by Winkelmann and Schott. On the contrary, the influence of the individual glass-forming oxides on the tensile strength and compressive strength seems to be quite the opposite. While Na_2O and especially K_2O increase the tensile strength, the two alkalies decrease the compressive strength considerably, potash more so than soda. It is the same with CaO, BaO and PbO which reduce the compressive strength, while they increase the tensile strength.

The calculation of the compressive strength of a given glass was carried out in the same way as was done the other properties (table 9).

The measured value was 93 kg. per sq. mm. and the agreement must be regarded as good.

Impact Strength

Föppl proposed the measurement of the impact strength as a means of characterizing the brittleness of glasses[18]. As a measure of the resistance to impact, he takes the total amount of impact work per cubic centimeter necessary for shattering the glass. He considers the quotient of compressive strength and impact work consumed, as determinative for the brittleness. The investigations of Föppl refer to a series of Schott's glasses for which he obtained widely different brittleness ratio values which vary in the ratio of 1.10.

Graf[19] in his work on the strength of glass as a structural material also included experiments on the resistance of glasses under load to impact. His experiments which have been published in detail, and which were made with a falling weight, showed that it is very hard to obtain exact data for impact strength. In the published data there are variations from the average amounting to ± 50%. A detailed consideration of the formation of cracks during the shattering of the glasses led the very remarkable result that a piece of glass that is destroyed by a slight amount of impact work shows only a few cracks; but a piece of the same kind of glass that withstands a large amount of impact work is penetrated by many cracks.

The investigations mentioned unfortunately did not permit us to recognize a relation between impact strength and composition: Föppl experiments, because they refer to glasses of very different composition and Graf's work because the glasses investigated have approximately the same composition, as was mentioned above.

We made our impact tests with a small pendulum (fig. 26); the experimental material was glass plates 7 x 1.5 cm. and about 2 mm. thick. As is seen in fig. 26, the plates were held in position by very strong springs with broad bearing surfaces, so that the free area of the glass

[18] A. Föppl, Die Sprödigkeit von Glas. Ber. München, 1911, p. 505.
[19] O. Graf, loc. cit.

plates was only 5 by 1.5 cm. As a measure of the impact strength we used the amount of energy consumed for shattering the glass plate which, according to well-known laws is $g(1-\cos\phi) \Sigma$ m r, (m is the mass of the pendulum, r the distance of the mass from the turning point, g gravitational acceleration and ϕ the angle of throw). We took damping into consideration, which amounted to 1% in the angle with a quarter oscillation. The impact strength as thus

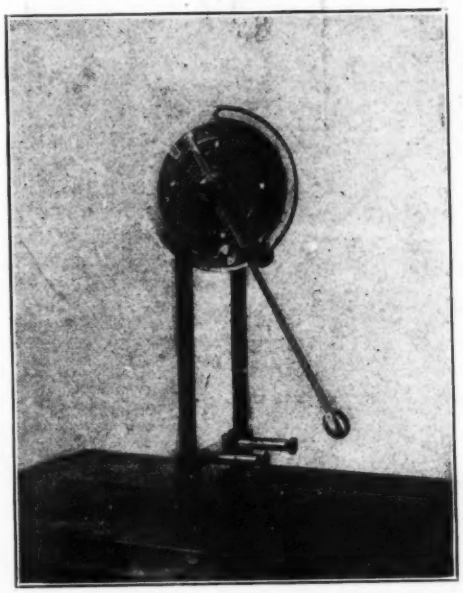


FIG. 26. APPARATUS FOR DETERMINING THE IMPACT STRENGTH.

defined naturally depends to a great extent on the thickness of the glass plate. Fig. 27 shows this relationship of impact strength to thickness in a factory glass. In order to obtain

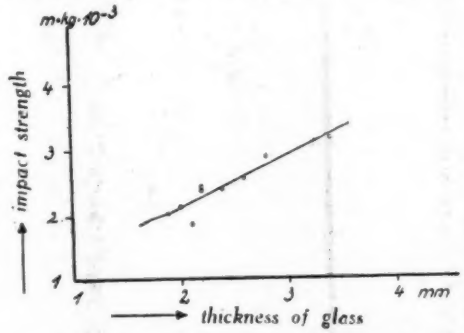


FIG. 27. IMPACT STRENGTH IN RELATION TO PLATE THICKNESS

comparable values, we used plates 2mm. thick for the determination of the impact strength. If glass of the prescribed thickness was not available, glasses of any thickness were used for the experiments, and the impact values were interpolated to 2mm. thickness according to fig. 27.

Further preliminary experiments showed that the results were always inaccurate when the diamond-cut glass plates were placed with the scratched part on the tension side, while better results were obtained if the scratches were on the compression side. In this case also, the agreement of the values cannot be regarded as good throughout. Occasional variations of individual values from the average up to $\pm$ 30% must be included. With enough experiments with good glass material (free from streaks) an agreement with an average of $\pm$ 2% can be obtained. Many of our experimental glasses unfortunately were not as perfect as is necessary here; consequently the errors are considerably greater.

The fire-polish of the glasses seems to exert great influence. Thus for an ordinary window glass of unknown source and 2mm. thick, there was obtained an impact strength of 1.86 mkg. x 10^{-3}, while etched samples 2mm. thick gave 2.67 mkg. x 10^{-3}. This increase in strength on etching the surface was observed similarly with many glasses. On the other hand, stressing the glass had no effect on the order of magnitude, as was found in our glass plates. For examples the following values were obtained for a manufactured glass:

Stressed .....2.15 m/kg. x 10^{-3}
Annealed .....2.10 m/kg. x 10^{-3}

(To be continued)

New Books

CHIMIE DES COLLOIDES. *(Industrial applications.) Lectures delivered at the Conservatory of Arts and Crafts of Paris, France, from May 16, until May 25, 1928, by Paul Bary, Consulting Engineer, formerly in charge of the School of Physics and Chemistry and the Central Laboratory of Electricity. Preface by M. E. Fleurent, Professor at the Conservatory of Arts and Crafts. 5½ x 7½ inches, 132 pages, 29 illustrations. Published by Donald. 92 Rue Bonaparte, Paris (6e), France. Price: in France 16 Fr. 10, abroad 20 Fr.*

This book is a short treatise on the subject of colloidal chemistry. It consists of a series of lectures delivered with the object of demonstrating the wide diversity of the use of these materials and the particular properties which they owe to their special condition. Interesting analogies are pointed out, existing between widely different substances, such as glasses, metals and soaps.

The number of technologists that may have an interest in this volume is considerable, since numerous industries deal with problems in colloidal chemistry, such as the manufacture of plastic materials, rubber, natural and artificial resins, cellulose and its derivatives, proteins (including gelatin, glue, caseine and leather), paints and varnishes, mineral oils, textile fibres, oils and fats, silica and the silicates, etc.

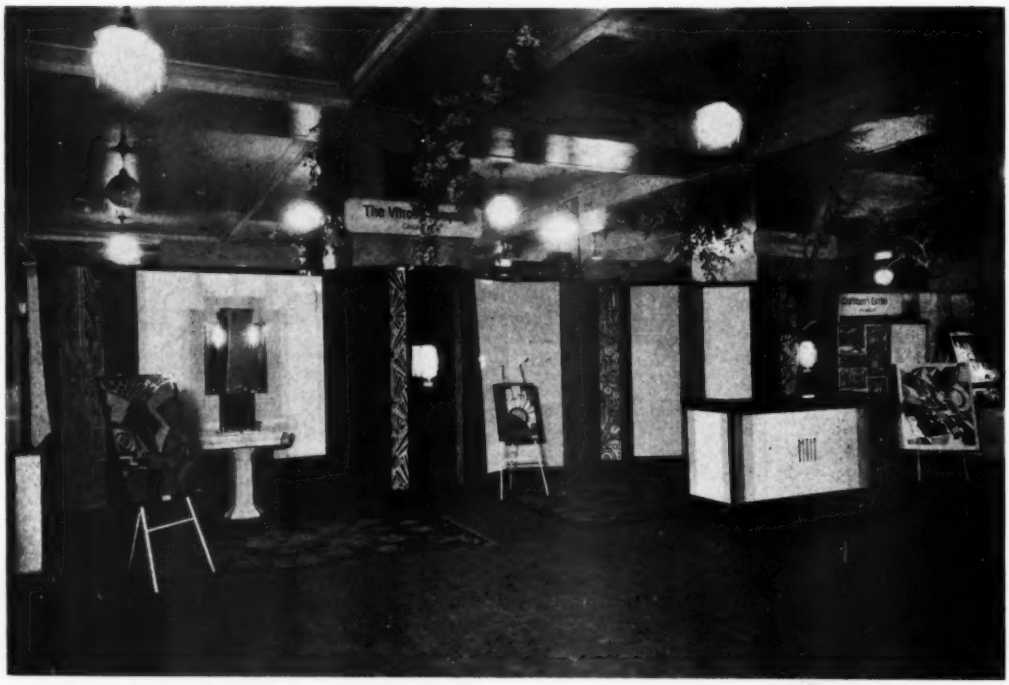
The first part consists of a theoretical treatise of the subject; the second part is devoted to the numerous technical applications.

VOLUMETRIC GLASSWARE. *By Verney Stott, B.A., F. Inst. P. Senior Assistant, National Physical Laboratory, formerly Scholar of Perthouse, Cambridge, 5¼ x 8½ inches, 232 pp., 40 Figs. and numerous tables. Published by H. F. & G. Witherby, 326 High Holburn, W. C. London, England.*

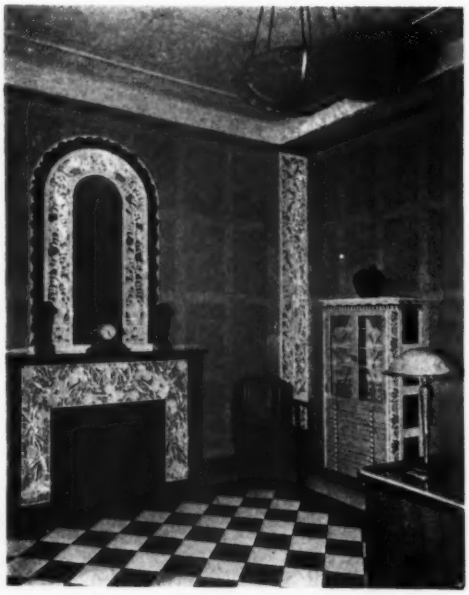
The keynote of this interesting and valuable book are the words of Mellor: "It is not at all uncommon to find that the weights in a laboratory have been the subject of wise skepticism while the volumetric instruments have been accepted with blind faith, and conversely."

The subject matter is divided in six chapters, dealing with Units of Volume, Flasks and Cylinders, Pipettes, Burettes, Graduating and Marking, Effect of Errors on Results of Volumetric Analysis. Sixty-five pages are devoted to calibration tables. The book is unusually high class as regards the quality of the paper and the design of the type. It should be of great value to all dealing with volumetric chemical analysis.

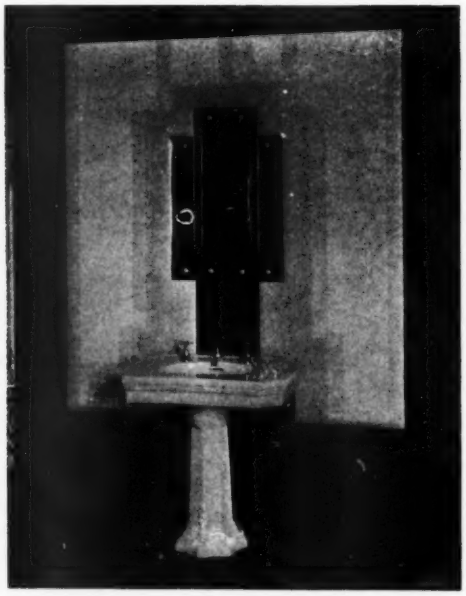
This volume is one of a series of books on glass and glass technology, edited by Professor W. E. S. Turner, of Sheffield University.



VITROLITE, A FORM OF GLASS, IS BEING USED IN MANY WAYS FOR CONSTRUCTIVE AND DECORATIVE PURPOSES.



AS A WALL COVER AND FIREPLACE EMBELLISHMENT.



ANOTHER APPLICATION OF VITROLITE IN THE BATHROOM

Vitrolite Offers Many Possibilities for Interior Decoration

By Walter Rendell Story

CHARACTERISTIC of the architecture and interior decoration of modern business buildings and homes is the number of new materials architect and designer have at hand with which to create decorative effects. In the not so distant past there were chiefly traditional materials—wood, polished stone, mosaics, tile or plaster. Today there are synthetic woods for paneling, artificial stone of many kinds, substances made from chemical earths, new metals for wall and ceiling, sheathing of monel metal and aluminum and a host of types of flooring ranging from linoleums to cork and rubber compositions.

Some of these materials enter also into furniture, such as the opaque, glass-like substance known as vitrolite, which modernistic designers employ for coffee and console table tops. In this type of material the public had an opportunity to see not only furniture but also complete rooms with walls, fireplaces, radiator grills and door and window trim, shown at the American ceramic exposition, held at the Stevens Hotel in Chicago during "Ceramic Week" last February.

This hard, vitreous, shiny material (belonging to the glass family, although the process of making it is somewhat different), first appeared as plain white slabs to cover the walls of restaurants. In its latest form, on which the art of the designer and the architect makes its impress felt, it has blossomed out in delicate colors and is ornamented with sand-etched designs touched with color.

One process provides an overlay of color above a black or contrasting background. The sand-etching process eats away portions of the outer coat down to the background color, thereby leaving the design in high relief. This form of decoration may be employed as tile accents in a plaster wall or in a large wall panel. The remarkable process, which does in an hour what it would take a worker in the usual marble technique weeks to do, may cut entirely through a slab, thereby making a grill effect. Cream-colored slabs thus treated are placed in front of steam radiators below a window.

The use of this glass-like material which is impervious to most of the detrimental effects of dust or water stains or fading that attack fabrics, paper, paints or plaster—produces a wall covering that has the permanency of the house itself. It is especially useful for entrance halls or foyers, which may often strike a new or exotic note and should be of a bright and welcoming color scheme. Decorative designs when applied are first incised by the sand-etching process and then colored. This insures permanence to the decoration, for the color is thus below the surface of the slabs.

This ornamentation may be daintily applied, as in the delicate lines and brightly colored flowers and birds of a Chinese dressing room. The octagonal sides of this interior are in china white, with the decoration in the rich hennas and blues and greens with which we are familiar in the decoration of Lowestoft china. Or a hallway may have panels with deep-cut patterns in the modern mode, the original black of the panel enriched with futuristic designs enameled in all the colors of the rainbow.

Another type of ornamentation developed in this vitreous wall covering is arrived at by cutting the design completely through the slab. In a mantel decoration a white border around the fireplace opening in this style in a conventionalized floral design is backed in black. Above a shelf in black a tall wall miror with a curved top is bordered with a similar cutout decoration, the mirror glass showing through.

CLOSE-UP OF VITROLITE DECORATED PANELS

The sunroom offers a special field in interior decoration for these ceramic products. In one room, against a decorated panel background a wall fountain was built up by using vitrolite to form the fountain basins. The house wall was covered with decorated panels divided by strips of contrasting color and the radiators below the windows were screened by white grills cut in patterns, with hunting dogs and luxurious foliage used as decorative motifs.

In the adornment of a bathroom in this glassy material there are many decorative possibilities, from facing the built-in tub to an etched and colored decoration above it. Black is particularly useful, for color shows up most effectively against the shiny dark background. Kitchens, although in more moderate decorative schemes, have been invaded by this new household material. The sanitary possibilities of this new form of glass and the ease with which it is kept clean make it especially useful in plain slabs for the table tops as well as for walls.

As the art of interior decoration becomes more important in this country its sphere of activity widens and new materials for construction and decoration are freely utilized.

From *New York Times Magazine*, Feb. 3, 1929.

Glass Industry

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Manufacturers of Sanitary Ware Should Standardize Colors

The rising tide of color has recently invaded the sanctuary that is the pride of every home and the envy of the foreign traveler: the American bathroom. In the past the walls and fixtures thereof were of a spotless white. Now we have an array of colors that is truly bewildering; green, blue, maroon, orchid, even "Rose Du Barry."

That this state of affairs means a serious problem to the glassmaker supplying bathroom fixtures in colored opal glass is obvious. To produce a delicate shade of color in a glaze is one thing. To reproduce this color in an entirely different medium, such as opal glass, under vastly different conditions, is quite another matter.

The usual procedure is that manufacturers of sanitary ware and bathroom tiles work out their color arrangement in accordance with their manufacturing conditions, and then invite glass manufacturers to produce opal glass fixtures that will closely match the ware. Everyone who knows the difficulties in producing colored opal glass, free from streak, evenly shaded throughout, will agree that this is difficult, in some cases impossible. Yet manufacturers of sanitary ware are surprised when the matter of cost is brought to their attention.

Color standardization for bathroom fixtures and kitchen ware has become a great necessity. Manufacturers of sanitary ware must come to an agreement with glassmakers, supplying their needs as to the color to be produced, in order to learn whether or not their color is such that it can be matched. The color must be restricted to a reasonable scale, and must be adopted by the majority of large manufacturers as standard, in order to allow glassmakers to go in for mass production.

The present wide range of color demanded is entirely out of reason. The home owner or home buyer notices at once the discrepancies that are unavoidable, and not being able to realize the enormous difficulties in matching glass and ceramic colors, wonders why these differences cannot be overcome. The glass manufacturer, after sometimes spending many days and a great deal of money to obtain certain color effects, finds that it is utterly impossible to make a profit on anything but very large orders.

If there ever was a need for standardization and co-operation, it is in this instance. To continue to produce the range of colors in sanitary ware now in vogue cannot possibly be satisfactory to the architect, the home owner, the maker of sanitary ware or the glass manufacturer.

This Marvelous Age

With new and startling inventions being made almost daily we are apt to feel that the present is the most marvelous period in human history. In a way this is true, but we should not lose sight of the fact that in our efforts to gain mastery over nature's secrets we are exhausting things that even nature herself can supply only once.

The things manufactured from raw materials that are abundant can be produced indefinitely, without permanent loss to the world. The bases of all manufacturing are heat and power, and water power is the only source that can sup-

ply these without loss. All heat and power generated by coal or oil is drawn from a reservoir that is being drained continually without the possibility of replenishment.

The present material prosperity is going hand in hand with a waste of fuel that is truly appalling. Future generations will look back on our present day as a period of prodigality without parallel in the world's history. The coal and oil business are both fighting for their very existence due to overproduction and waste, at a time when the use of fuel is greater than ever before.

There never was a time when a world-wide, statesman-like vision with regard to fuel was more needed than at present. Selfishness and greed are wasting for slight gain what rightfully belong to future generations. The United States, controlling as it does probably the largest share of the world's fuel, has a greater interest at stake than any other nation. Our government should take the initiative of regulating the production of fuel, the prevention of waste, the fuller utilization of these priceless substances which are drawn from the earth.

We are being told glibly that when our present full resources will run low we will utilize the tides of the sea, the heat of the sun, the energy locked up in the aton to replace that which has gone forever from our grasp. Those who make these predictions most confidently are men who least understand technical and scientific problems. Such statements emanate usually from newspaper men or novelists with superficial, half-baked notions about science and technology.

We know what we have. Let us preserve it, and not be led astray by possibilities and hopes that may never materialize.

For the first time in American history a man occupies the presidency who by his training and experience is able to cope with this tremendous problem. It is respectfully submitted that the question of fuel preservation is worthy of the attention of our Chief Executive, equally or more so than other great problems now pressing for solution.

Indian Ceramic Society

On April 15, 1928, the Indian Ceramic Society was organized, the inaugural meeting being held in the Library Hall of the Chemistry Building of the Benares Hindu University. The Society publishes a quarterly paper, which is devoted to the pottery, glass, enamel, cement and other silicate industries.

The following abstract of an editorial, appearing in the third issue of the Journal undoubtedly is of interest:

> Back of modern technology is the general scientific knowledge of Physics, Chemistry, Mathematics, etc. Thirst for knowledge actuated many workers throughout past centuries to investigate the general principles of "Nature." They did not seek material gain from it, neither did they keep their knowledge a secret. On the contrary, people like Galileo have paid with their lives for this sort of work. We do not quite realize to today the great sacrifice these people had to make, although we are reaping the harvest of their labors now. The particular principles developed by Bhāskara, Kanāda, Newton, Dalton, Faraday, Guy Lusac, Kelvin, Thompson or Einstein may not have a direct bearing on the melting of more glass but these principles and the tradition that these workers have left behind them, of co-operation, of ignoring the geographical boundaries, etc., are the foundations of our knowledge. Our humble homage to all the scientific workers of the past.
>
> In particular we wish to pay homage here to the ceramic investigators. Wedgwood was perhaps the first to use science in this art and to publish the results of his work. The ceramic industry used to be a secret process. The scientific workers have broken these bonds and much of our modern progress can be directly traced to the attitude of these men. We therefore pay our tribute to Wedgwood, Winkleman and Schott, to LeChatelier, to Seger, to Colonel Edward Orton Jr., to Dr. Mellor, Dr. Turner and co-workers, Messrs. Bowen, Grieg, and Wright, to Mr. Purdy, Mr. Bleininger, Mr. Peddle, Dr. Washburn and others who have all shown us "Light" in our path and have paved our way to a great extent. To them we owe our present knowledge of the alphabets of Ceramics, whatever little we know of it today.
>
> Perhaps our homage may be best paid by adding similar information as they have contributed and by developing a fraternal spirit such as they have shown.

German Society of Glass Technology at Vienna

The German Society of Glass Technology will holds its eleventh meeting in Vienna, from May 14 until May 16. The following papers will be presented:

Glass decoration in past and present times, by Professor W. v. Eiff, Stuttgart.

Mechanical firing of glass furnaces, by Dr. H. Kalsing, Weiszwasser, Ober Lausitz.

Devitrification, by Dr. Ing. Viktor Groszmann, Prague.

Polarization of glasses, by Dr. Robert Ettenreich, Vienna.

Electrical conductivity and constitution of glasses, by Professor Dr. Adolf Smekal, Halle a. S.

Something about glass colors, by Professor Dr. Kasper Killer, Haida.

Basic oxides and glass properties, by Dr. Norbert Kreidl, Vienna.

Entries Invited for Metropolitan Industrial Art Exhibition

The Second International Exhibition of Industrial Art, featuring decorative glass and selected rugs, under the auspices of the American Federation of Arts, will be opened on November 4, 1929, at the Metropolitan Museum of Art, New York. The exhibits will be selected from the work of individuals and producing firms in the several European countries and the United States, which have been making the most significant contributions to contemporary design.

Producers of modern glassware are invited to submit examples of their work. Selections will necessarily be limited in number. Objects eligible for entry will include: Glass tableware, with or without color, blown, cast, molded, or of any other type; decorative glass, with or without color, blown, cast, molded or of any other type; architectural panels without color.

Certain conditions including one that the material offered must not have been shown previously in a public exhibition in the United States must be met. The only expense involved for exhibitors will be the packing and shipping costs to one of the addresses in the list of several cities scheduled for the exhibition which includes New York, Boston, Philadelphia, Chicago, St. Louis, Dayton, O., Pittsburgh, Cincinnati, Baltimore. Each museum will pay transportation cost to the next stop on the circuit and the Federation will return the objects to exhibitors prepaid. Full information regarding the exhibition may be obtained from the American Federation of Arts, Department of Industrial Art, 40 East 49th Street, New York.

Professor Turner to Sail May 3

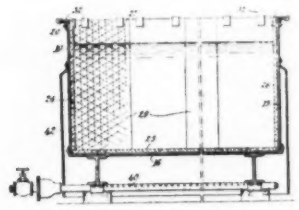
Professor W. E. S. Turner, head of the School of Glass Technology, The University, Sheffield, England, who arrived in this country in March and who has been making a tour of the glass manufacturing districts, is scheduled to sail from Montreal by the Cunard line on May 3. During his visit he has several times expressed his deep appreciation of the cordial reception given him throughout the industry by the hundreds of old friends which he has made on his various visits to the United States during past years and by many new ones. It has been made evident to him that his great research work in the glass field is thoroughly appreciated.

Recent Patents

NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

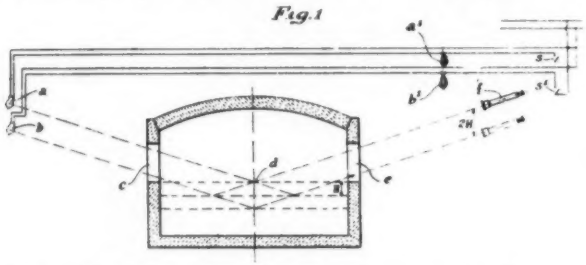
Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington, D. C. Price 10c each

TANK FOR CHROMIUM-PLATING BATHS. U. S. 1,709,022. April 16, 1929. Leo D. Jensen, Chicago, Ill., assignor to United Chromium, Incorporated. Filed 4/12/29. A tank for chromium plating baths, of metal, with glass sheets covering the inside metal faces, adapted to cut off stray currents, and to prevent short-circuits between the electrodes and the inside of the metal tank, and means for holding said sheets in place, said means holding the upper edges of said glass sheets.



APPARATUS FOR THE PRECISE DETERMINATION OF THE LEVEL OF GLASS IN A FURNACE. U. S. 1,706,857. Mar. 26, 1929. Aime Mathe, Paris, France, assignor to Hartford-Empire Co. Filed 8/10/26. An apparatus for the precise determination of the level of the molten glass in a tank furnace comprising a source of light at one side of said furnace, an observing instrument at the opposite side of said furnace, said furnace having a pair of openings through one of which light from said source may pass there-

Fig. 1



into and through the other of which the image of said light source may be observed by said instrument as reflected by the top surface of the molten glass, means for varying the relative positions of

Fig. 2

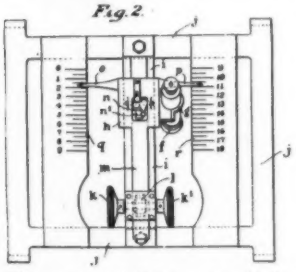
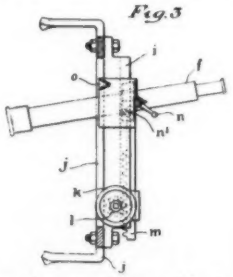


Fig. 3



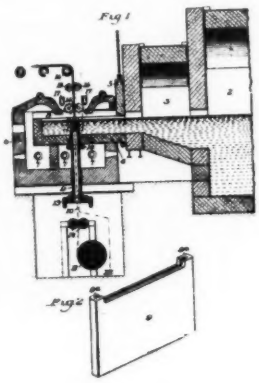
said source of light and said instrument in accordance with the level of glass, and means for determining the amount of such variation, whereby accurately to determine the level of the glass in said furnace.

GLASS-FORMING MACHINE. U. S. 1,702,498. Feb. 19, 1929. Aeblrt N. Cramer, Toledo, O., assignor to The Owens Bottle Company. Filed 2/25/27. A glass forming mold comprising a body portion, a mold bottom including an annular section and a vertically movable plunger section in said annular section, and means automatically operable at predetermined time intervals to interlock the mold bottom sections.

PROCESS AND APPARATUS FOR MAINTAINING SHEET GLASS TO WIDTH. U. S. 1,684,438. Sept. 18, 1928. Enoch T. Ferngren, Toledo, O., assignor to The Libbey-Owens Sheet Glass Company. Filed 12/16/25.

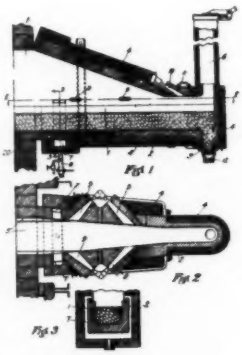
COATING METHOD. U. S. 1,698,302. Jan. 8, 1929. Byron Cassius Goss, Cleveland, O., assignor to General Electric Company. Filed 4/22/21. The method of forming a coating on a glass surface which consists in applying thereto a liquid comprising an insoluble body material, an alkaline silicate and an alkaline hydrate, the proportions being such that there is present materially more of the alkaline hydrate than is contained in commercial grades of the alkaline silicate, drying the coating and afterwards treating the coating with a fixing solution which reacts therewith to form an insoluble compound.

METHOD AND APPARATUS FOR MAKING WIRE GLASS. U. S. 1,708,662. Apr. 9, 1929. Henry F. Clark, Oakmont, Pa., assignor to Window Glass Machine Co. Filed 7/15/20. Provides an extremely simple method and apparatus by means of which sheets of wire glass may be continuously drawn to be afterwards severed into the desired sizes. The inventor claims the steps consisting of passing a wire fabric upwardly through a guide and protector which initially projects above the level of a bath of glass, engaging the wire fabric above the bath, lowering the guide and protector sufficiently to give the glass access to the wire fabric, and continuing the feed by engaging successive portions of the wire fabric with the engaging means above the bath, substantially as described. In operation the wire fabric is drawn up through the wire guide and protector 9 and through any suitable arrangement of feed rolls or wheels 15 to a bending roller 16, after which it passes horizontally into a suitable flattening annealing chamber. In starting the operation, the combined wire guide and protector is raised to the position in which its upper edge is above the level of the glass bath, so that in engaging the wire fabric with the draft wheels or rollers, this initial portion of the fabric will not be coated with glass.



BOTTLE-DELIVERY DEVICE. U. S. 1,679,824. August 7, 1928. Frederick Helfenstein, Jr., and John Helfenstein, Bismarck, N D., assignors on one-third to John Nathan of Bismarck, N. D. Filed February 17, 1926.

METHOD AND APPARATUS FOR DELIVERING VISCOUS GLASS. U. S. 1,708,037. Apr. 9, 1929. Oliver M. Tucker and William A. Reeves, Columbus, O., assignors to Hartford-Empire Co. Filed 10/15/24. Apparatus and the method for delivering viscous glass from a furnace comprising a long narrow spout having a flow channel formed to be wider at its intake end than elsewhere along its length, said flow channel having a discharge orifice, means for regulating the temperature of the glass as it leaves the furnace and passes into the relatively wide inlet of the spout and means for applying a confined flame burning under pressure to the walls of the orifice and to the glass in said orifice.



METHOD AND APPARATUS FOR DELIVERING VISCOUS GLASS. U. S. 1,708,069. Apr. 9, 1929. Oliver M. Tucker and William A. Reeves, Columbus, O., Filed 9-29-24.

Big Merger Still Grips Trade's Imagination

What has been termed by some of the participants "the twenty million dollar merger" of the Owens Bottle Company and the Illinois Glass Company was unanimously approved by the stockholders of the former company at their annual meeting in Toledo on April 17 and became effective with that action. The actual assets and good will value involved in the transaction, however, vice-presidents: R. H. Levis of Alton; W. J. Crane of Toledo; James Morrison of Toledo; and Charles Boldt of New York.

William E. Levis and R. H. Levis were elected to the board of directors while William Ford of Toledo was re-elected chairman of the board. These directors were re-elected: Wm. H. Boshart and Harry E. Collins of Toledo; Marshall Field, Charles

WILLIAM H. BOSHART
President
Owens-Illinois Glass Company.

WILLIAM E. LEVIS
Vice-President and General Manager
Owens-Illinois Glass Company.

Two of the big men of the glass container industry. Mr. Boshart's accomplishments during his long connection with the Owens Bottle Company are well known. Mr. Levis, for some years very active in the Illinois Glass Company, has been hardly less in the limelight than his new partner. His strong personality impresses all who have dealings with him. Mr. Levis is one of those able executives of the new school who learned some of the fundamentals in his training during the world war. Among the trophies he brought back to this country, which he served as a lieutenant in France, is the Distinguished Service Cross, awarded for conspicuous valor in action. He is a "go-getter" in peace or war, and he usually goes till he gets what he goes after.

undoubtedly total a sum several times that amount. The Owens-Illinois Glass Company is the largest company of its kind in the world.

The coming together of these two powerful interests and the pooling of their combined resources and energies has resulted in the creation of an organization that cannot be considered otherwise than as practically invincible in any industrial undertaking it is likely to attempt. United, and with their combined forces effectively co-operating for a single purpose instead of competing, as before, it seems that nothing can stop them from going on to greater and greater success, in both the domestic and foreign fields.

Since the first announcement of the project the question has frequently been raised as to what will be the ultimate effect on the rest of the bottle trade of the amalgamation of its two largest manufacturers with their practically unlimited resources, but no great uneasiness on this subject has been manifested. Large modern concerns are usually leaders in and developers of good business and production methods, which tends to make conditions in the industries they are connected with better for all concerned.

Most large concerns spend considerable amounts of money for research, experimental and development work which ultimately benefits the whole industry. They have a stabilizing effect on it. With their aid an industry is enabled to accomplish things for itself that unorganized smaller units cannot undertake.

After the stockholders had ratified the merger plans at the Toledo meeting, officers for the new corporation were elected. The directors named William H. Boshart president, while William E. Levis of Alton, Ill., president and general manager of the Illinois Glass Company, was elected vice president and general manager of the combination.

H. G. Phillips of Toledo was elected vice-president and treasurer and John H. McNerney, secretary. These men also were elected H. Sabin, E. P. Currier, Francis H. McAdoo, Charles Boldt and Fred Schwenck, all of New York. H. G. Phillipps is also a director.

Executive Committee: Wm. H. Boshart, chairman, W. E. Levis, H. Collin, Marshall Field, Charles Boldt, William Ford.

Finance Committee: William Ford, chairman, Charles Boldt, Marshall Field, Charles H. Sabin. Officers: H. Boeschenstein, vice-president and general sales manager; J. H. McNerney, secretary and assistant treasurer; E. F. Martin, assistant secretary and assistant treasurer; F. G. Morfoot, assistant secretary and assistant treasurer, A. J. Reidmayer, assistant treasurer.

Through the deal, the Illinois Glass Company will now receive from the Owens Bottle Company cash and securities as follows: $5,000,000 in cash; $5,000,000 par value of 5 per cent unsecured debentures; $8,000,000 par value 6 per cent preferred stock redeemable at 110, and 20,000 shares of common stock. There will be no offering of the new securities, either to the stockholders or the public as all the debentures and stock to be issued are to be delivered to the Illinois company and will be held by it as a permanent investment.

The Illinois Glass Company is to deliver to the Owens company all its asests and those of the subsidiaries named, including plants, equipment, current assets, and good will. Their properties are to be delivered clear of all liabilities of every kind. Their current assets will aggregate $8,000,000. The Illinois company will use nearly all of the $5,000,000 cash it is to receive to pay off its existing debenture issue as well as its current and other liabilities. The properties are to be acquired and payment therefor is to be made as of the close of business December 31, 1928.

The combined cash and securities of the Owens and Illinois companies as of December 31 last, after deducting the $5,000,000 cash payment to be made was $1,202,614.33. Combined inventories were $11,905,324.21. By the acquisition of the Illinois

company's assets, approximately $8,000,000 will be added to working capital and by the cash payment to be made to Illinois Company $5,000,000 will be deducted from working capital, making a net increase of $3,000,000 in this item. The tentative balance sheet shows that net working capital of the combined companies as of December 31, 1928, will be $15,847,772.75 which is considered ample for any needs that can be foreseen.

The maximum annual security charges ahead of common dividends will total $930,000 it is figured. This is divided as follows: Interest on debentures $250,000; sinking fund on debentures $200,000; dividends on preferred stock $480,000. Through the operation of the sinking fund, the interest charge on the debentures will automatically decrease each year, it was stated. An audit of the profits for the past five years of the properties to be acquired, shows that they have been substantially more than these charges and it is estimated that as soon as the economies which are expected of the consolidation are effected, the earnings of the properties will be much greater.

Pointing to the fact that the Owens Bottle Company for several years has become concerned chiefly with the manufacture of bottles rather than with licensing machines on a royalty basis, President Boshart, in his address to the stockholders said:

"The Illinois Glass Company, as a licensee, has been for a long period of years a substantial contributor to our royalty income. The principal patents included in its license from us will expire within the next few years, when your company will necessarily face the loss of this substantial revenue. By the acquisition and consolidation now to be affected, we will more than replace this large royalty income through manufacturing profits to be derived from the operation of the Illinois Glass Company's business.

"Increasing use is being made of glass bottles which are displacing containers made of other materials. It is my judgment that the present volume of the business represents far from the limit of what the ultimate development of the industry promises. Your company will enter upon its enlarged field of activities with an increased working capital to meet these conditions and with an organization thoroughly acquainted with the business through many years of experience."

After describing the prosperity the Owens Bottle Company has enjoyed for years through careful, able management and outlining the many benefits of the merger, President Boshart continued:

"We will also get back the exclusive right to manufacture large size water bottles, demi-johns and carboys on Owens machines, which this company granted to Illinois Glass Company years ago and which has turned out to be very profitable. Illinois Glass Company also manufactures large quantities of fruit jars for household preserving, which our company heretofore has not manufactured.

"I feel justified in placing emphasis on the value of the good-will that rests in the Illinois Glass Company and which we will acquire. To gain the full effect of the good-will, the name of our company will be changed to the Owens-Illinois Glass Company. It remains the same company under a new name, reflecting the history and properties of the two companies.

"We believe that the interest rate on the debentures and the dividend rate carried by the preferred stock, are quite favorable to your company in view of the currently high rates for money. Had these terms not been agreed upon before the development of the present money situation, it would probably have been impossible to have financed this purchase so advantageously to your company."

The British Ceramic Tourists Arrive

A large number of members of the Ceramic Society of England who are making a visit to the United States and Canada arrived in New York on April 28-29. An elaborate itinerary has been arranged for the entire trip for the various sections of the Society according to whether they are interested in refractories or other ceramic products. The American Ceramic Society's summer excursion meeting is being combined with the British ceramists' tour.

On Monday evening, April 29, a banquet was held at the Pennsylvania Hotel.. Ross C. Purdy was in charge. Several glass technologists were present including Prof. W. E. S. Turner of Sheffield who is just ending a six weeks' visit in this country, and Prof. A. Silverman who will have charge of the Pittsburgh District tour of the British ceramists. The long tour began on Tuesday, April 30, leaving by bus via the Holland vehicular tunnel for Perth Amboy, N. J., where various ceramic plants were visited. Arrangements were made for a banquet in New Brunswick. Numerous plants in the vicinity were scheduled for visits. On Wednesday, May 1 the party was to leave for Metuchen, N. J., by auto bus, visiting the General Ceramic Company's and Sayre & Fisher plants. A visit was then planned to Princeton University and a stop overnight at Trenton, N. J., where it was planned to visit several plants the next day. The party will then leave for Philadelphia, the whitewares and building material groups visiting plants and leaving for Washington in the evening. The refractory groups detrain at Baltimore to be met by a committee of which Carl C. Hildenberg, president of the Carr-Lowrey Glass Company is chairman.

This plant is to be visited on Friday, May 3, and also the General Refractory Company's plant. A harbor trip on a city boat will be taken in the afternoon and late in the afternoon the party will proceed to Washington and stay overnight at the Hay-Adams House. On Saturday, May 4, the visitors will be taken to the Bureau of Standards. They will be welcomed by Dr. George K. Burgess, director and P. H. Bates, chief of the division of clay and ceramic products. They will also be welcomed by Dr. A. L. Day, director, and Dr. G. W. Morey, chemist, when visiting the geophysical laboratory. A visit will also be made to the tomb of the unknown soldier. The refractories division will leave for St. Louis and the whitewares division remain in Washington overnight.

On Sunday, May 5, the whitewares and building materials groups will move on to Baltimore. The refractories division will be arriving at St. Louis late in the afternoon and leave that night for Mexico, Mo. Among members of the reception committee will be J. L. Green, president of Laclede-Christy Clay Products Company, R. H. McKelvey, vice-president of the same company, N. S. C. Walsh, vice-president, and C. W. Parker, general manager of the Mississippi Glass Company. On Monday the whitewares and building materials groups will visit ceramic plants in Baltimore and in the afternoon inspect the Carr-Lowrey Glass Company's plant and later leave for Beaver Falls, Pa.

Meantime the refractories men will visit the A. P. Green Fire Brick Company's plant at Mexico, Mo., and leave for St. Louis that evening. On Tuesday, May 7, they will visit the Laclede-Christy and Evens & Howard plants, Fulton Fire Brick Company and the Harbison-Walker Refractories Company. The whitewares and building materials groups will arrive at Beaver Falls, Pa. on Tuesday, May 7. From then on almost innumerable trips are planned for visiting ceramic districts throughout the Middle West. Among those of interest to glass men will be a visit to the Armstrong Cork Company, manufacturers of high temperature insulating brick and cork insulation.

At Pittsburgh, Professor Alexander Silverman of the University of Pittsburgh is chairman of a committee to entertain the refractories groups. The Westinghouse research laboratory will be visited, also the Mellon Institute. On May 9, the refractories groups will leave for Harbison-Walker Refractories plant and the Kier Fire Brick Company at Salina. On Friday, May 10, the refractories groups will leave Pittsburgh for visits to various centers. On Saturday, May 11, they will visit the Harbison-Walker Refractories Company and the United States Refractories Company at Mount Union, Pa., and on Monday the same companies plants at Clearfield and Woodland, Pa. On the afternoon of May 11 they will visit Pennsylvania State College.

On Sunday, May 12, the refractories groups will have lunch at the Center Hill Country Club and play golf. On Tuesday, May 14, the North American Refractories Company plants at Lumber City and Curwensville, Pa., will be inspected. The party will then leave for Buffalo and stay overnight at the Statler Hotel. The whitewares and building materials groups will also arrive at Buffalo, and on Wednesday, May 15, the entire party will motor to Toronto via the Peace Bridge over the Niagara River. The party will stop at the King Edward Hotel. On Thursday, May 16, all will return by motor via the Niagara Gorge and Falls. Various ceramic plants will be visited.

The refractories and building materials groups will leave Buffalo and arrive in New York at 7:50 A. M. on the morning of May 17, The whitewares division will join them in New York at the Hotel Pennsylvania and the entire party will sail from New York at noon on Saturday, May 18.

The Glass World and What It Is Doing

News of the Industry

Big New Window Glass Plant for Oklahoma

The city of Henryetta, Oklahoma, has been selected by the Pittsburgh Plate Glass Company as the site for their new Southwestern window glass plant. This was a victory for the city over some seventeen competing cities representing five different states. The proposed plant, it is said, will cover 40 acres and will cost approximately $2,000,000. Production capacity will be about

AIRPLANE VIEW OF HENRYETTA, OKLAHOMA

900,000 boxes of window glass per year. An average of 350 or 400 men will be employed with an annual payroll of approximately $800,000.

The plant will be equipped with the flat glass drawing process developed at the Company's sheet glass plant at Mount Vernon, Ohio, and Clarksburg, W. Va., and will practically duplicate those

ONE OF THE LOCAL CELEBRATIONS

plants except that they will be laid out on a larger scale with a view to doubling the capacity some time in the future. The officials of the Pittsburgh Plate Glass Company agree that Henryetta has every resource available with which to meet their varied demands; the fuel supply being the prime factor in their decision. The city is practically in the center of the largest Oklahoma natural gas field and the Central States Power & Light Corporation can supply this fuel at a very satisfactory rate. In addition to the favorable gas supply, the city is in the center of one of the largest coal fields to be found in the central west, in fact geological surveys and estimates of engineers bring out the fact that there are over 71,000 acres containing over 200,000,000 tons of unmined coal. This coal has been analyzed by the chemists of the Pittsburgh company and has been found to be a good gas producing coal which will fully meet their demands should natural gas become unavailable for economical production.

The city is also favorably located for the obtaining of raw materials and the distribution of the manufactured product; all raw materials used in the manufacture of window glass can be obtained at a short distance. About two-thirds of the manufactured product will be shipped North and the remaining one-third will supply the South and Southwestern territory. In fact this plant is to supply the territory lying west of the Mississippi and east of the Rocky Mountains.

We are informed that the announcement of the Pittsburgh Plate Glass Company's decision aroused joyous enthusiasm in the city and that a "Henryetta Jubilee" was held to celebrate the occasion, with over 20,000 persons in attendance from all sections of Eastern Oklahoma. The photograph shows Assistant Secretary of War Patrick J. Hurley addressing a gathering on Main Street during the celebration. The flag shown in the picture is claimed to be the largest flown from a pole in the United States. It is 43 feet in length and the stars are 13 inches in diameter.

Pittsburgh Plate $4,000,000 Plant at Santa Ana

The selection of Santa Ana, California, for the site of the long projected Pacific Coast plate glass manufacturing plant was officially announced on April 23 by George Raymer, secretary of the Santa Ana Chamber of Commerce. Mr. Raymer said that a payment of approximately $180,000 had been made by the Pittsburgh concern on the purchase of property, including the Walter Neil tract of 80 acres at Bristol street and Fairview avenue, and about 120 acres owned by the city known as the "sewer farm."

H. S. Wherrett, president of the company, and H. B. Higgins, vice-president, were active in the negotiations leading to the decision. J. H. Fox, J. N. Belleville, J. E. Bechtel and others took part in the preliminary investigations.

Acme Glass Company Affairs

Owing to the unexplained disappearance of Samuel Kostin, president and Samuel Glickstein, secretary-treasurer of the Acme Glass Company, 2331 12th Avenue, New York, and to the fact that the weekly pay checks of the employes of the company's factory at Olean, N. Y., early in April were returned unpaid by the bank marked "no funds," the company was placed in the hands of receivers by Judge John R. Hazel of Buffalo. Three Olean men were appointed equity receivers as follows: Former Judge Frolich W. Kruse, Edward W. Fitzgerald, secretary of the Olean Chamber of Commerce, and Willis B. Snell, manager of the two Acme plants in that city. The Irving Trust Company of New York is ancilliary receiver.

Cast Polished Plate Glass Report Issued

The United States Tariff Commission has issued a 60-page printed report of its recent investigation into the costs of production of cast polished plate glass in the United States and in the principal competing country, which was submitted to the President August 22, 1928.

The report outlines the information obtained in the investigation on the uses and grades of polished plate glass used in various industries. Data on production, organization and distribution of the production in the United States and Europe, the costs of production, methods and conditions of marketing, transportation, and final cost comparisons are given.

The booklet also contains the statement of the views of Commissioners Marvin, Brossard and Lowell on the investigation and another statement by Commissioners Dennis, Dixon and Clark. Appendix A gives the detailed cost of production data in the United States and Belgium. Appendix B—Classification of

polished plate glass for tariff purposes. Appendix C—the proclamation of the President concerning increase in the duties on polished plate glass which was determined to be necessary and has been put into effect. A limited number of copies of this report have been supplied to the Superintendent of Documents, Government Printing Office, Washington, D. C. from whom it may be obtained at 15 cents per copy.

Decision Reversed in Marble Machine Case

An opinion handed down by Judge Page on April 8 in the United States Circuit Court of Appeals for the Seventh Circuit, reverses the decision of the District Court of the United States for the Northern District of Illinois, Eastern District rendered October 22, 1927 and the complaint of the Akro Agate Company, Clarksburg, W. Va., against the Peltier Glass Company of Ottawa, Ill. was dismissed. In the trial held in the District Court the decision was that the defendant had infringed the three first claims of the Hill patent 1,164,718 issued December 21, 1915.

A hearing was held before Judges Alschuler, Page and Anderson in Chicago. Among matters gone into in considering the Hill invention was the influence, if any, of the Christensen invention and use. The evidence on this point offered at the District Court trial was rejected as insufficient to show anticipation. In the trial before the Circuit Court of Appeals seven witnesses of Akron, O., some of whom were employed in the factory of M. F. Christensen & Co. over various periods, testified that they worked in the factory making marbles by machinery and one man asserted that he worked on a machine similar to that shown at the trial as Exhibit A. The judges are of the opinion that the evidence clearly established the use for much more than two years prior to the Hill invention of the machine shown in Exhibit A and that the defendant's Exhibit A is a machine of the Christensen type or similar to it. Much other detailed evidence was submitted in the case.

Johns-Manville Quarterly Statement

Including the Celite Company, Banner Rock Products Company and other subsidiaries, the Johns-Manville Corporation and subsidiaries report for the quarter ended March 31, 1929, net profit of $1,106,089 after expenses, Federal taxes, etc., equivalent after 7 per cent preferred dividend requirements, to $1.30 a share on 750,000 no par shares of common stock. This compares with $772,705, or 85 cents a share, on common in the first quarter of 1928. The 1929 figures include earnings of the recently acquired subsidiaries while those of 1928 exclude these companies.

New Canadian Glass Plant Projected

A new glass plant for the British Columbia Glass Company at New Westminster, B. C., has, according to the U. S. Consul at Vancouver, been designed by American engineers and is being backed by American capital. An annual production valued at $1,000,000 is said to be anticipated to replace present importations from the United States and Eastern Canada. Soda ash will probably be obtained from the United States and sand from Belgium, while other raw material is available locally.

Name of Safety Glass Company Changed

Early in April it was announced that the name of the Pittsburgh Safety Glass Company would be changed to Duplate Corporation. This is a subsidiary company of the Pittsburgh Plate Glass Company and the Dupont Viscoloid Company. The name Duplate was given to its products, shatterproof plate glass, "armor plate" bullet proof glass, and laminated window glass which is manufactured at Creighton and made for the automobile industry, banks and other consumers.

Glass Container Association Meets in May

The Glass Container Association will hold its meeting at the Traymore Hotel, Atlantic City, May 1-3. As this meeting will offer an excellent opportunity for the bottle and container manufacturers to discuss the recent notable merger of the bottle companies and as other important subjects need attention it is expected that there will be a large attendance at this meeting. It is reported that the golf tournament will be held on the first day of the meeting and the trophies presented at the dinner to be held at the Traymore.

Large Gain in Plate Glass Production

The production of polished plate glass for the month of March, 1929, was 13,144,216 sq. ft., as compared to 11,289,396 sq. ft. produced in the preceding month, February, 1929. The production for the corresponding month of last year, March, 1928, was 11,951,385 sq. ft.

Feeder Patent Trial

The suit of the Hartford-Empire Company against the Hazel-Atlas Company came up for trial at Pittsburgh on April 1 in the United States District Court of Western Pennsylvania. C. P. Byrnes of Pittsburgh, Vernon M. Dorsey, of Washington and W. J. Belknap of Detroit and R. D. Brown of Hartford represented the Hartford-Empire Company and the defense was represented by attorneys McAllister of Pittsburgh, Philbin of New York and Eccleston of Washington. During the first week of the trial the direct testimony for the plaintiff was completed and followed by the witnesses for the defense the following week. The completion of the trial was expected during the latter part of April.

Amsler-Morton Absorbs Cruikshank Engineering

The J. W. Cruikshank Engineering Company, J. W. Cruikshank, president, of Pittsburgh, Pa., was taken over by the Amsler-Morton Company of the same city on April 19. No statement concerning the terms of the agreement has been issued. It is understood that Mr. Cruikshank will act as consulting engineer on matters relating particularly to Mr. Cruikshank's specialty—plate glass engineering.

Construction Record for March

New building and engineering work contracted for during the past month in the 37 States east of the Rocky Mountains amounted to $484,847,500, according to F. W. Dodge Corporation. The above figure shows an increase of 34 per cent over the total for February of this year, but there was a drop of 18 per cent from the March, 1928, total. Of the eight districts reviewed below, Texas was the only territory showing a drop from the preceding month's totals, and it was the only area showing an increase over the totals for March of last year. The February total, $361,273,900 in amount was 12 per cent less than the January, 1929, record and it was 22 per cent below the total for February of last year.

H. L. Dixon Returns to His Home

The innumerable friends of H. L. Dixon, who is sometimes referred to as the Dean of the glass manufacturing industry, will be pleased to know that he and Mrs. Dixon planned to leave on April 26 the sanitarium and clinic at Clifton Springs, N. Y., where he went to recuperate from a serious illness, for his home in Dormont, Pa. His friends all hope that it will only be a short time until he is able to freely resume his former activities.

American Refractories Institute Spring Meeting

The annual meeting of the American Refractories Institute will be held in the French Lick Springs Hotel, French Lick, Ind. on May 21 and 22.

Trade Activities

Javier Vertiz, Estaciones 32, Mexico, D. F., is establishing a small glass factory in that city.

The Diamond Alkali Company, Pittsburgh, Pa., are now in their new offices at 436 Seventh Avenue. The new telephone number is Grant 7500.

B. F. Drakenfeld & Co., Inc., 45-47 Park Place, New York, at their annual meeting on March 30, 1929, elected Erwin F. Zeiller to be assistant secretary of the company.

The Seneca Glass Manufacturing Company, Morgantown, W. Va., are putting their large tank at the Seneca B. factory,

Star City, W. Va., into operation after being shut down since last summer.

The Magnolia Bottle Company's plant at Bristow, Okla., has resumed operations with two units. It is reported that after July 1 flintware will be made instead of beverage bottles.

The Improved Glass Process Company, Inc., are reported to have held their annual meeting in Cincinnati on March 21. New directors and a change in management are said to have been provided for.

The Eastern Silica & Chemical Company, Winchester, Va., producers of glass sand, announced early in April that construction would be started on a new pulverizing mill which they expect will be completed within three or four months.

Graham Brothers Corporation, who are interested in the Libbey-Owens Sheet Glass Company and other glassmaking enterprises have moved their office from 1 East 44th Street, New York to the New York Central Building, north of and opposite the Grand Central Terminal.

Middleport, O., reports were in circulation early in April to the effect that New York City interests will erect a large glass factory for making fruit jars and milk bottles in the Cheshire bottoms, near Hobson on the Lindsey and Roush farms.

The Sterling Glass Company, Lapel, Ind., which shut down for repairs to their large glass tank, recently announced that other improvements would be made including a new brick engine room 55 x 30 feet in size. New engines and air compressors and other equipment is being installed.

George W. Aiken, the well-known glass man who has been connected with the H. J. Heinz Company, Sharpsburg, Pa., is now in charge of a glass factory in Cuba. Mr. Aiken has had considerable experience in the management of foreign glass factories in several different countries.

H. C. Fry Glass Company, Rochester, Pa., has scheduled a meeting for Tuesday, April 30 by its stockholders to consider a plan of reorganization for the company. It is said that the plan has already been approved by the owners of 75% of the outstanding stock.

The Roessler & Hasslacher Chemical Company are moving their main office, until recently at 709 Sixth Avenue, New York to larger quarters in a new tall building at 10 East 40th Street. This is a very central location convenient to the Grand Central Station, Baltimore & Ohio city station, and Pennsylvania Stations. The Chemists Club is just around the corner.

John C. Wiarda & Company, Brooklyn, N. Y., has been acquired by the Kalbfleisch Corporation, 200 Fifth Avenue, New York. The purchase has been effective April 1, 1929. The capital stock of the Wiarda company has been purchased by the latter company. The business will continue to be conducted under the direction of George E. Taylor as a division of the Kalbfleisch Corporation.

The Triplex Safety Glass Company of North America at a meeting of stockholders on March 26 acted on the proposed amendments to the certificate of incorporation to permit the American company to have exclusive selling rights in certain territory in South and Central America. An arrangement was made by which in exchange for founders' shares held by the English company and all obligations for the payment of royalty to the English Company, are to be exchanged for common stock in the American company which will be deposited for a period of years by agreement between the English company and A. L. Haskell, president of the Triplex Safety Glass Company of North America.

Recent Deaths

Charles K. Finkbeiner

Charles K. Finkbeiner, of the Vidriera Monterrey, Mexico, died on March 18 at San Antonio, Tex., after an operation for appendicitis. Mr. Finkbeiner was a native of Scotland.

Fred Woltjen

Fred Woltjen, president of the Advance Glass Company died at his home in Newark, O., on April 6. Mr. Woltjen was born at Bremen, Germany, in 1865 and came to this Company with a factory at Utica, O. This factory was country in 1882. Some years later he entered the glass manufacturing industry and in 1905 organized the Advance Glass destroyed by fire in 1911 and he then became interested in the Advance Glass Company of Newark, O.

William E. Swindell

William Emmett Swindell, a member of the firm of Swindell Brothers, Baltimore, Md., and a manager of their New York office for twenty-three years, who died suddenly at his home on the morning of March 18 from a heart attack, had not been in good health since a severe attack of influenza early in the winter.

He was born November 3, 1878, in Baltimore and was educated in the public schools, later studying at the Baltimore City College. After graduation he joined the organization of Swindell Brothers, and for a number of years was in charge of production and sales all over the United States. In 1906 he was made a member of the firm and came to New York City where he opened the New York office.

Mr. Swindell lived at East Orange, N. J., and is survived by his widow, Addie Duncan Swindell.

Mr. Swindell was very well known and highly respected throughout the toilet preparations industry where his unfailing good nature, his thorough knowledge of the business and his desire to co-operate had won for him a host of friends.

Coming Meetings

The Stained Glass Association of America will hold its annual meeting at Philadelphia on June 24.

The American Bottlers of Carbonated Beverages annual convention and exposition at Atlantic City, November 11-15.

The Twelfth Exposition of Chemical Industries will be held at the Grand Central Palace, New York on May 6-11 inclusive.

Inquiries Received

455. Please advise us as to the name of any manufacturer or jobber that can make us a small four-ounce, special shaped bottle, say in fifty gross lots.

456. Where can I obtain beveled plate glass with beveled hole in center?

What the World Wants

Specific Inquiries for American Goods Received in the Department of Commerce, Washington, D. C.

Canada—37601, Artistic glassware.
Philippine Islands—37784, Cheap glassware.
Canada—37893, Glass globes for street lighting standards.
Canada—37304, Glass battery jars.

Glass Stock Quotations

PITTSBURGH STOCK EXCHANGE, APRIL 19, 1929

Reported by Moore, Leonard & Lynch, Union Bank Building, Pittsburgh, Pa.

	Bid	Asked	Last
American Window Glass Com.	..	..	..
American Window Glass Pfd.	..	..	87
American Window Glass Mch.			
Common	..	..	25
Pfd. Cumulative	..	..	46
Pittsburgh Plate Glass (New)	64	64½	64½
Standard Plate Glass:			
Common	..	..	5½
Pfd. Cumulative	..	..	19½
Prior Pfd.	..	..	32
United States Glass	12	12½	11½

READERS' WANTS AND OFFERS

POSITION WANTED

Diplomat Engineer, 33 years old, foreigner, with many years experience in the manufacture of window glass (Fourcault) and plate glass, familiar with all manufacturing details, having a thorough knowledge of tank management, a knowledge of English and French languages, having worked abroad (China, Russia, Roumania and Germany) desires engagement for July 1st. Send offers to SW-7 care THE GLASS INDUSTRY.

Current Prices of Glass-Making Materials

April 22, 1929

Quotations furnished by various producers, manufacturers and dealers.

		Carlots	Less Carlots
Acid			
Citric (dom.)	lb.	.46	.46
Hydrochloric (HCl) 20° tanks, per 100 lb.		..	1.10
Hydrofluoric (HF) 60% (lead carboy)	lb.	..	.13½
52% and 48%	lb.	.10	.10-.11½
Nitric (HNO_3) 38° carboy ext. Per 100 lb.		5.50	5.75
Sulphuric (H_2SO_4) 66° tank cars	ton	15.50	..
Tartaric	lb.		.38
Alcohol, denatured	gal.	..	.52
Aluminum hydrate ($Al(OH)_3$)	lb.	.04½-.05	.05½-.06
Aluminum oxide (Al_2O_3)	lb	..	.07
Ammonium bifluoride (NH_4) FHF	lb.	..	.21-.22
Ammonia water (NH_4OH) 26° drums	lb.	.03	.03¼
Antimony, metallic (Sb)	lb.	..	.09⅝
Antimony oxide (Sb_2O_3)	lb.	..	.12-.14
Antimony sulphide (Sb_2S_3)	lb.	..	.14
Arsenic trioxide (As_2O_3) (dense white), 99%	lb.	.04	.05
Barium carbonate ($BaCO_3$)			
Precipitated	ton	57.50-59.50	60.00-61.50
Natural, powdered, imported	ton	45.00	50.00
Barium hydrate ($Ba(OH)_2$)	lb.	..	.04¾-.05½
Barium nitrate ($Ba(NO_3)_2$)	lb.	.08¼	.08½
Barium selenite ($BaSeO_3$)	lb.	..	..
Barium sulphate, in bags	ton	28.00-35.00	..
Barium sulphate, glassmaker's, carlots, bulk, f.o.b. shipping point,	ton	..	16.00
Bone ash	carlots, lb.	.06	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	.02½-.02¾	.02¾-.03¼
Boric acid (H_3BO_3)	lb.	.05½-.05¾	.06-.07
Refined	lb.	.05½-.05¾	.06-.07
Cadmium sulphide (CdS)—			
Red	lb.	..	1.20
Orange	lb.	..	1.00-1.25
Yellow	lb.	..	1.20-1.40
Chromium oxide (Cr_2O_3)	lb.	.24	.25
Cobalt oxide (Co_2O_3)			
In bbls.	lb.	..	2.10
In 10 lb. tins	lb.	..	2.20
Copper oxide			
Red (Cu_2O)	lb.	..	.30
Black (CuO)	lb.	..	.25-.30
Black prepared	lb.	..	.30
Cryolite ($Na_3Al\ F_6$) Natural Greenland Kryolith)	lb.	.09	.10-.10½
Artificial or Chemical	lb.	..	.09½
Epsom salts ($MgSO_4$) (imported) Per 100 lb.		..	1.15-1.20
Feldspar—			
100 mesh	ton	11.00-20.00	15.50-22.00
80 mesh	ton	11.00-11.75	14.50
40 mesh	ton	11.00	13.50
Fluorspar (CaF_2) domestic, ground, 95-98% (max SiO_2 2½%)			
Bulk, carloads, f.o.b. mines	ton	32.50	..
In bags or barrels	ton	36.50	41.50
Formaldehyde	lb.	..	.09½
Graphite (C)	lb.	..	.04-.07
Iron oxide—			
Red (Fe_2O_3)	lb.	..	.03¼-.03½
Black (FeO)	lb.	.03½	..
Kaolin (f.o.b. mine)	ton	9.00	..
English, lump, f.o.b. New York	ton	14.50-25.00	24.50-30.00
Kryolith (see Cryolite)			
Lead chromate ($PbCrO_4$)	lb.	..	..
Lead oxide (Pb_3O_4) (red lead)	lb.	.09½	.10½
Litharge (PbO)	lb.	.08½	.09½
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	11.50-12.50	..
Burnt (CaO) ground, in bulk	ton	8.00	..
Burnt, ground, in paper sacks	ton	10.00-11.00	..
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.15-2.25	2.30-2.60
Limestone ($CaCO_3$)		2.00-2.50	..
Magnesia (MgO)—			
Calcined, heavy (in bbls.)	lb.	.06	.07
light (in bbls.)	lb.	..	.23
extra light (in bbls.)	lb.	..	.37
Magnesium carbonate ($MgCO_3$)	lb.	.06	.07
Manganese 85% (MnO_2)	lb.	.04	.04½
Nickel oxide (Ni_2O_3), black—			
for nickel content	lb.	..	.35
Nickel monoxide (NiO), green—			
for nickel content	lb.	..	.35
Plaster of Paris, bags	ton	..	23.00-29.00
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	.09	.09¾
Ground	lb.	.11	.12
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.06½	.07
Hydrated 80-85%	lb.	.05¾	.06¼
Potassium chromate (K_2CrO_4)	lb.	..	.23-.32
Potassium hydrate (KOH) (caustic potash)	lb.	.07⅛	.08
Potassium nitrate (KNO_3) (gran.)	lb.	..	.05⅞-.06
Potassium permanganate ($KMnO_4$)	lb.	.16	.16½
Powdered blue	lb.	..	.24-.26
Rochelle salts, bbls.	lb.	..	.23
Rouge	lb.	..	..
Rutile (TiO_2) powdered, 95%	lb.	.15-.20	.20-.25
Salt cake, glassmakers (Na_2SO_4)	ton	22.00	..
Selenium (Se)	lb.	..	1.90-2.00
Silver nitrate ($AgNO_3$)	(100 oz.) per oz.	..	.38½
Soda ash (Na_2CO_3) dense, 58%—			
Bulk, on contract	Flat per 100 lb.	1.22½	..
In barrels	Per 100 lb.	1.55-1.57½	2.40
In bags	Per 100 lb.	1.37½-1.40	..
Spot orders.. .025 per 100 lbs. higher			
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.07	.07½
Sodium hydrate ($NaOH$) (caustic soda) Solid	Per 100 lb.	2.90	..
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	lb.	.03⅞	.04½
95 per cent	Per 100 lb.	2.25	2.50
Sodium selenite (Na_2SeO_3)	lb.	..	2.35
Sodium fluosilicate (Na_2SiF_6)	lb.	.05	.05½
Sodium uranate (Na_2UO_4) Yellow or Orange	lb.	..	1.50
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.45	3.80-4.00
Flowers, in bags	Per 100 lb.	3.10	3.45-3.65
Flour, heavy in bbls.	Per 100 lb.	2.85	3.20-3.40
Tin chloride ($SnCl_2$) (crystals)	lb.	.39	.37½
Tin oxide (SnO_2) in bbls.	lb.	..	.54
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots	lb.	..	1.50-2.25
Zinc oxide (ZnO)	lb.	.08½	.12
American process, Bags	lb.	.06½	.07
Zircon			
Granular (Milled .005-.02c higher)		.07	.07¼-.08
Crude, Gran. (Milled .005-.02c higher)		.03½	.04-.05

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

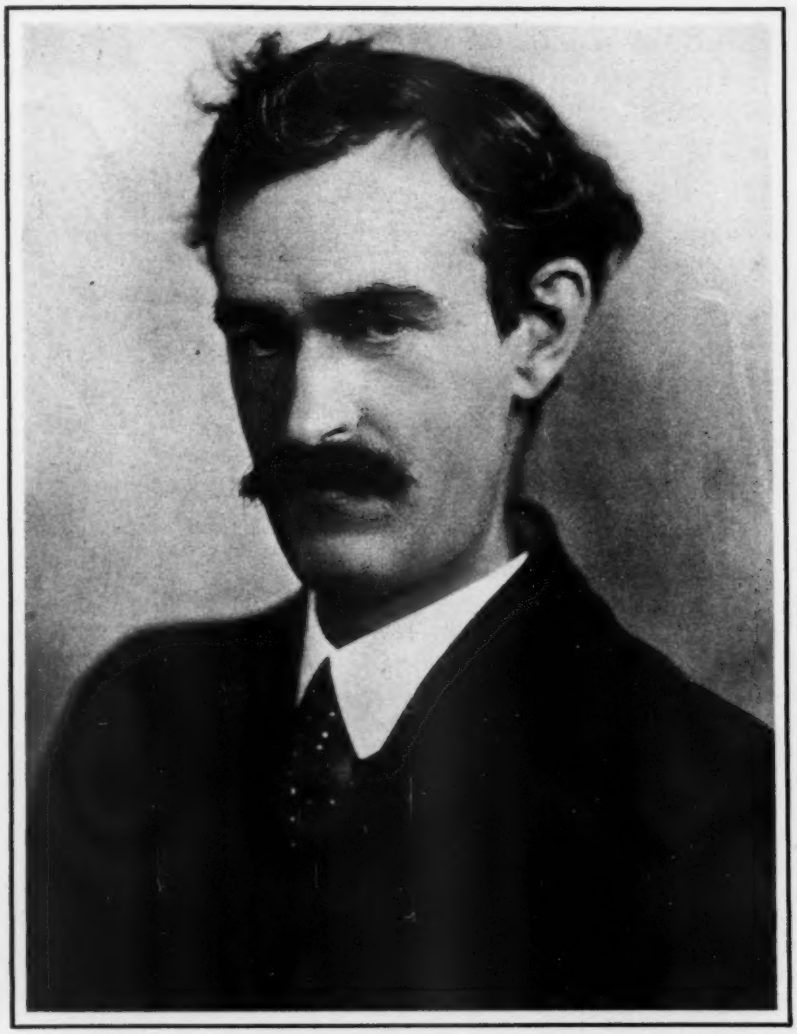
Corrected to March 23, 1929

	February 1928 Quantity	February 1928 Value	February 1929 Quantity	February 1929 Value	Two Months Ending Feb. 1928 Quantity	Two Months Ending Feb. 1928 Value	Two Months Ending Feb. 1929 Quantity	Two Months Ending Feb. 1929 Value
Glass and glass products (total)	.....	717,473	.....	854,359	.....	1,434,006	.....	1,735,740
Plate and window glass—								
Window glass, common, box 50 sq. ft.	1,471	9,360	1,740	9,245	2,267	15,193	2,775	15,413
Plate glass, unsilvered, sq. ft.	138,073	50,788	180,833	56,628	230,400	85,722	388,392	130,744
Other window and plate glass lbs.	416,531	46,031	249,748	30,180	624,682	78,964	574,058	67,330
Glass containers (bottles, vials and jars)	.....	233,323	.....	255,750	.....	489,137	.....	534,590
Table glassware, plain	.....	106,622	.....	128,541	.....	203,985	.....	234,968
Table and other glassware, cut or engraved	.....	8,332	.....	6,650	.....	18,206	.....	14,570
Lamp chimneys and lantern globes lbs.	164,809	34,731	142,489	29,836	353,955	69,132	279,641	59,025
Globes and shades for lighting fixtures lbs.	124,788	48,156	157,410	63,825	242,644	89,361	346,858	122,873
Chemical glassware lbs.	18,950	13,358	22 009	18,778	34,615	29,137	40,209	37,496
Electrical glassware, except for lighting lbs.	665,621	40,467	623,541	48,283	908,110	70,918	1,380,557	98,325
Other glassware	.....	126,305	.....	206,643	.....	284,251	.....	420,406

IMPORTS

Corrected to March 23, 1929

Glass and glass products	.....	1,102,799	.....	1,155,463	.....	2,032,482	.....	2,277,944
Cylinder crown and sheet—								
Unpolished, not bent, obscured, beveled, etc.—								
Weighing less than 80 pounds per case dut. lb.	2,462,145	75,421	2,654,411	71,588	5,356,104	163,511	6,097,342	160,245
Weighing 80 pounds or over per case dut. lb.	2,509,784	122,076	2,214,736	85,736	4,686,118	233,073	5,456,302	206,279
Polished and bent, obscured, beveled, colored, etc., unpolished and polished, and all silvered dut.	.....	42,986	.....	56,866	.....	74,025	.....	104,768
Plate glass—								
Polished, unsilvered dut. sq. ft.	1,275,218	269,689	1,903,904	393,099	2,083,777	447,798	3,305,933	685,080
Other dut. sq. ft.	112,181	22,761	120,492	29,761	201,987	46,638	177,548	41,235
Bottles, vials, jars, demijohns and carboys, molded or pressed dut.	.....	21,649	.....	24,388	.....	43 251	.....	53,739
Table and kitchen utensils dut.	.....	17,320	...	19,262	.....	29,187	.....	36,117
Glassware, cut or decorated dut.	.....	195,097	.....	207,093	.....	376,650	.....	427,435
Blown glassware, n. e. s.—								
Bottles, ornaments, gauge glasses and other n. e. s. dut.	.....	61,387	.....	33,955	.....	128,111	.....	100,877
Bulbs for electric lamps dut. No. 1	877,722	8,839	1,886,049	14,101	2,268,841	23,100	4,032,633	31,597
Chimneys, globes, shades, prisms and other illuminating glassware dut.	.....	69,689	.....	77,768	.....	131,499	.....	155,908
Articles and utensils for chemicals, scientific, and experimental purposes dut.	.....	44.619	.....	36.180	.....	86.991	.....	77,154
Other glassware dut.	.....	151.266	.....	105,666	.....	248.648	.....	197,510



PROFESSOR WILLIAM ERNEST STEPHEN TURNER, O. B. E., D. Sc., M. Sc., F. INST. P.

PROFESSOR WILLIAM ERNEST STEPHEN TURNER, Honorary Secretary of The Society of Glass Technology, Editor of the Society's Journal, and one of the world's foremost glass technologists became interested in the glass industry and its problems as a result of the exigencies of the world war. Prior to 1914 Professor Turner was engaged in teaching physical chemistry and in research, and had won great distinction in that subject, having published some thirty research problems concerned with physical chemistry. While already well known among a restricted group of scientists, his success in solving problems of the glass industry have made his name known the world over to everyone interested in glass. No other field was in more urgent need of scientific treatment, and the glass industry in every country has been benefited by the fact that his exact and brilliant mind has been attracted by its problems.

As a result of a report on the position of the glass industry in England made by Professor Turner to the Council of the University of Sheffield in 1915, that body decided to establish a Department of Glass Technology. Little or no opportunity for research work was found until 1917. Since that year the Department has published (to the end of April 1929) about 206 papers involving the results of research. This number does not include articles of ephemeral interest such as articles in newspapers, semi-popular magazines, etc.

In November 1916 The Society of Glass Technology was founded. The first number of its journal appeared in May 1917. This publication is without a rival in the field of glass technology for the value of its papers, containing fundamental researches on glass.